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ABSTRACT

A science and engineering fair is a competition based on the quality of projects done by students, the results of which are reported through exhibits and oral presentations at the fair. Fairs operate on a step basis. Students who win in small, local fairs, move to a city fair, then to a regional fair, and may be chosen to represent that fair in the International Science and Engineering Fair (ISEF). The finalists whose project abstracts are reported in this book won the honor of presenting their projects at the 38th ISEF in San Juan, Puerto Rico, in May 1987 as the result of being chosen the best in 360 affiliated fairs. Abstracts are organized by project categories. These 13 groups are described and include: behavioral and social sciences; biochemistry; botany; chemistry; computer science; earth and space sciences; engineering; environmental sciences; mathematics; medicine and health; microbiology; physics; and zoology. An index is also included of all the finalists. (CW)

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ABSTRACTS

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ABSTRACTS

38th International Science and Engineering Fair

Abstracts of the Finalists

of the

International Science and Engineering Fair

held in

San Juan, Puerto Rico

May 10-16, 1987

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PREFACE

A science and engineering fair is a competition based on the quality of projects done by students, the results of which are reported through exhibits and oral presentations at the fair.

The purpose of fairs is threefold: to stimulate in young people an active interest in science and engineering; to provide an educational experience through being exposed to the judges and to the public; and to give public recognition to talented students for the work they have done.

Fairs range in scope from the local level, which may involve one class, or one district, to ones which may involve a large city, a county, a state, or even a nation. While there are no exact figures, it is estimated that over one million student projects are undertaken each year in the United States, and that there are fairs in more than twenty other different countries.

Science and engineering fairs operate on a step basis, with students who have won in small fairs participating in large fairs as representatives of the fairs in which they have previously won. Thus, an individual might participate in a local fair, move to a city fair, then to a regional fair, and be chosen there to represent that fair in the International Science and Engineering Fair.

The finalists whose project abstracts are reported in this book won the honor of presenting their projects at the 38th ISEF in San Juan, Puerto Rico, in May 1987 as the result of being chosen the best in 360 affiliated fairs.

Science Service, the nonprofit institution devoted to the public understanding of science, which conducts the International Science and Engineering Fair, pays tribute to these finalists, to their teachers, and to the thousands of individuals and organizations who made possible the presence of these ISEF finalists in San Juan.

We wish to thank the General Motors Foundation for the funds which supported the printing of this book.

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BEHAVIORAL AND SOCIAL SCIENCES

IMAGINARY PLAYMATES AND AUDIENCES

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The purpose of this research was to first, show that the imaginary playmate was a simpler form of the imaginary audience and second, that the presence of imaginary playmates and a positive imaginary audience in the lives of children and adolescents will help them to cope with stress. It was hypothesized that the imaginary playmate and the imaginary audience were related, and that their presence would help to reduce stress caused by everyday life.

A questionnaire containing four separate tests dealing with the subjects background, childhood, and their life today were sent to twenty-five Nebraska schools. Within each school the following age groups were tested: 11 to 14, 14 to 17, and 16 to 19. Fifteen schools returned their questionnaires.

Upon the return of the questionnaires the last two tests were scored. The test scores,which measured the self-esteem and stress level of the subjects were statistically analyzed using a t-test and a single correlation.

In conclusion it was found that none of the t-tests run rejected their null hypothesis at an Alpha of .1. Only the correlation run upon the female subjects showed a correlation between the stress level and the self-esteem level. These statistical conclusions show that there was no statistical difference between the age groups stress level and their self-esteem, but there was a correlation between the self-esteem of the female subjects and their stress level.

PEER INFLUENCE: AN EXPERIMENTAL STUDY OF THE SOURCE EFFECTS OF PEER INFLUENCE ACROSS AGE GROUPS

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Recently, a community task force in Rio Grande County, Colorado, was commissioned to study and seek solutions to the problem of adolescent "drinking and driving" in the area. The task force decided to implement a peer-counseling program in which high school students would counsel junior high and elementary students. This research is an attempt to determine which group of youngsters would be the ideal target for this program. In the experiment three levels of students, 6th grade, 8th grade and 10th grade, were tested with different sources of influence in order to determine which group might be the most susceptible to the influence of a student counselor. Each level was divided into three treatment groups. Treatment A was tested with questions involving no influence. Treatment B was tested with questions involving peer influence. Treatment C was tested with questions involving older-peer influence.

Analysis of the data suggested that the opinions of the subjects were affected by the influence applied and that different age levels show varying results according to the age of the source of influence applied.

A COMPARATIVE STUDY OF MEMORY RETENTION THROUGH SUPPLEMENTARY SENSORY AIDS

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This experimental investigation was constructed to determine the impact of visual and auditory cues in improved academic performance in primary and middle school students. To validate this, I devised two simple prose excerpts that would be presented to 677 4th, 5th, 7th, and 8th grade students of different academic ability levels. The 7th and 8th grade version contained 49 words, and the 4th and 5th had 45 words. This group was divided into five categories each receiving the passage on one of five colors- red, blue, green, yellow, or white. The group on white paper served as the control for they were presented information strictly as facts and no visual stimulation in the way of color. A second group was presented with a 48 word poem (7th and 8th) or a 46 word poem (4th and 5th). The poem was on plain white paper and each student kept in mind that memorization was the prime objective. A third group listened to a poem set to a simple melody. This study showed that the group presented with color did 52.96% better than the control in 7th and 8th grade students and 28.393% better in 4th and 5th grade students. For all grades green presented the most improvement, followed by yellow, red, and blue. The group that incorporated rhyme did an average of 46.914% better (7th and 8th) and 46.34% better in the younger grades. Melody was strong in the 4th and 5th grades with an average of 53.06% improvement and in 7th and 8th grades melody improved 31.49% over the control. Therefore, the younger children are more receptive to melody and rhyme, which are auditory aids, whereas older children are more effected by visual stimulation.

It can be concluded from this evidence that sensory aids are extremely influential in memorization. These tools serve as enhancements in memory retention and with the proper use can produce a major improvement in American classrooms. If begun at an early age sensory aids still prove effective. Therefore, it can be concluded that if memory started to be improved at an early age, the capabilities in later life can be endless.

#First Award - Federal Aviation Administration
Second Award - American Optometric Association and the Auxiliary to the American Optometric Association
Second Award - United States Air Force

BEHAVIORAL STUDY OF THE AMERICAN CONCKROACH PERIPLANETA AMERICANA WITH SPECIAL ATTENTION TO THE EFFECTS OF ENVIRONMENTAL STRESSORS ON THEIR ESCAPE SYSTEM:

Pagán, Luis M., Francisco Rodríguez López H.S., Guayanilla, P.R. 00656
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Along with studying the habitat of Periplaneta americana, I have performed an analysis of their escape system.

The movements of any organism through the air generates tiny currents. I found that Periplaneta americana flees from possible danger by detecting these currents with an arrangement of very sensitive hairs in their cerci, an amazingly precise wind detector.

With subtle air puffs I tested their ability to locate the source of the currents and to turn away to evade what they think is a threat to their survival. The intensity of the wind was recorded in a wind meter.

These orthopterans are very widespread due to the fact that they prefer antihygenic places such as swage ducts and others.

A Great part of the investigation was pursued to show the relative behavioral changes that occur when Periplaneta americana are subjected to conditions of artificially created environmental stressors: crowding, cover (darkness) vs exposure (to light), temperature and humidity, diet, and wind current velocities.

Biochemical assays are being carried out to determine insecticide effects on their escape systems

The last part of the investigation suggested that ultrasonic sound vibrations can exterminate the cockroach Periplaneta americana. The cockroaches exhibited different behavioral patterns and other changes at certain frequencies.

Acheta assimilis has cercal receptors similar to these of cockroaches. I have found that crickets, like cockroaches, show turning responses to air puffs and to strikes by toads.

THE EFFECTS OF B VITAMINS ON CASES OF DEPRESSION

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The ultimate purpose of science is to help humanity, whether it be physically, mentally, or both. The purpose of the three year study "The Effects of B Vitamins on Cases of Depression" was to find if the B Vitamins Thiamine and Dimethylglycine can be used as a dietary supplement to cure or allieviate the symptoms of depression.

To do this, 600 teenagers between the ages of 14 and 18 were pretested using the "Beck Inventory" to determine each one's level of depression. (Teenagers were chosen because of the high rate of depression their age group experiences, and they are easily contacted and controlled in and around school.) Those students who scored in such a way to indicate depression and filled out the "Beck Inventory" correctly were asked to participate. Of those 133 students, eleven returned their permission slips and were given a 28 day supply of Thiamine (B_1), Dimethylglycine (B_{15}), a placebo (sugar, baking soda, and baking powder), or no supplement at all. After 28 days, the participants, or experimental group, were given the "Beck Inventory" for a second time. The scores were then compared using statistical analysis and percentages, by individual; by supplement; by age; by sex; and on overall improvement or regression.

From the experiment, it was found that all the groups improved except for the non-supplemented group, which regressed. Only the Thiamine and Dimethylglycine groups succeeded in overcoming the Standard Deviation and therefore showing signifigant improvement.

Such signifigant results can bring hope the hundreds of thousands of people who suffer from depression, and it can be concluded that B vitamins could be used as a successful treatment for depression.

#PHYSIOLOGICAL AND PSYCHOMOTOR EFFECTS OF CIRCADIAN DESYNCHRONOSIS ON THE PACIFIC TREE FROG HYLA REGILLA

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Objective: My objective is To determine how Jet Lag (Circadian Desynchronosis) affects; Heart Rate, Respiration Rate, Fly Catching Response, of the Pacific Tree Frog (Hyla regilla).

Methods: The Frogs were tested at eight different times over a six day period.

Fly Catching is tested by placing a frog in a gallon jar with a fly and timing how long it takes the frog to catch the fly. This was done three times for every frog tested.

Jumping Response is tested by placing a frog in the jumping arena. Three Jumping Responses were recorded for each frog tested.

Heart Rate is tested by counting the number of large slow collapses on the side of frog. This number was multiplied by four to get the number of Beats per Minute.

Respiration Rate is tested by counting the number of times the vocal sac expands. Each vocal sac expansion equals one exhalation and one inhalation. This number was multiplied by four to get the number of Breaths per Minute.

Conclusion: Heart Rate and Respiration Rate were not noticeably affected by simulated time zone changes. The Fly Catching Response time increased in all of the East and West flights. The jumping distance decreased in all of the East and West flights.

The more time zones that the Frogs crossed the Fly Catching time increased. The time zones that the Frogs crossed decreased the distance that the Frogs Jumped.

The Psychomotor Functions of the Frogs were affected more by the simulated Eastward flights than than the Westward flights.

#Third Award - General Motors ISEF/Behavioral and Social Sciences

#COMPUTER GENERATED REHABILITATION IN THE TREATMENT OF VISUOSPATIAL AGNOSIA: PHASE IV

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A phenomenon involving increased visuospatial abilities and their link with computer rehabilitation, first identified through this research in 1983, has been significantly demonstrated over the last three years in establishing a basis for including computer generated visuospatial rehabilitation programs in the on-going therapy of individuals who have been diagnosed as having visuospatial agnosia. Observations during the Phase III experiment indicated that as visuospatial abilities increased certain dysfunctional behaviors decreased. Results achieved during the Phase III study pointed significantly to the rehabilitative effect of an original computer software program developed to increase visuospatial skills. The final phase of this study identified ten subjects presently enrolled in a day school for Behavior Dysfunctional children who were diagnosed as having perception deficits and self-stimulatory behaviors. The Phase III software program was used as a Behavioral Covariate between the subject and the caregiver. It was predicted that as the subject's visuospatial skills increased, the number of self-stimulatory events would decrease. It was further predicted the decrease would generalize across three ecological settings. The ABA research design was used as the experimental model. Results yielded a significant decrease in self-stim events during the last baseline across all three settings. Several factors identified during the intervention stage produced some unexpected results. The subject's self-stim events increased significantly during the intervention stage, then decreased significantly during the stage III baseline. Conclusions indicate there is a definite link between visuospatial agnosia and self-stim behaviors. Based on this research, the school has established a computer laboratory to continue visuospatial rehabilitation.

#First Award - American Medical Association
First Award - American Speech-Language-Hearing Association
First Award - Sigma XI, The Scientific Research Society
First Award - United States Air Force
Fourth Award - General Motors ISEF/Behavioral and Social Sciences
Honorable Mention - American Optometric Association and the Auxiliary to the American Optometric Association

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#JUVENILE DISTRESS PHASE II

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Stress is known as being a non-especific response of the organism to any demand. Everything that has life suffers from stress, children, adolescents, etc. This investigation was conducted among the adolescents.
It was believed that the principal cause for stress among the adolescent was due to their lower grades, at least that was the response of the majority of them when asked what they considered was the cause for their tension.
Within this investigation I was able to give evidence of real reason for the tension among the adolescents, age range from 13 to 15 really due to "family problems". These family problems provoked a lack of interest in their studies, wish consequently lowered their grades. The adolescents seen to not recognize this phenomenum, believing as being the only reason for their tension, lower school grades.
It is without a doubt discovered and confirm thatadolescents do not understand what is happening to them or the cause of their tension.
It is necessary that within the Educational System and within the home itself we help these adolescents by educating them and by these means they shall be able to distinguish their problems and be able to combat them.

#Third Award - General Motors ISEF/Behavioral and Social Sciences

*THE EFFECTS OF EXTRACTS OF *PANEOLUS SPHINCTRINUS* (FR.) QUELET, 1872 IN THE BEHAVIOR OF TWO MEMBERS OF THE ORDER RODENTIA: SPECIAL ATTENTION TO A CHEMICAL STUDY TO TRY TO DETERMINE THE PRESENCE OF HALLUCINOGENIC SUBSTANCES IN THIS PASTURE MUSHROOM

Pérez, Eileen, Lola Rodríguez de Tió H.S., San Germán PR 00753
Urb. Porta Coeli, B-8, San Germán, PR 00753

One of the sacred hallucinogenic mushrooms employed in divination and other magic ceremonies by the chinantec and mazatec indians of Mexico is a member of the small genus *Paneoulus*. It is known as pasture mushroom or intoxicating mushroom. *Panaeolus sphinctrinus* is a delicate yellowish brown mushroom up to four inches tall whose status among the hallucinogenic mushroom is in doubt.

This study represents an attempt to study the effect of extracts of the fungus *Panaeolus sphinctrinus* on the behavior of the hamster, *Mesocricetus auratus* and the mouse, *Mus musculus*.

Three experimental groups were set up all consisting of two hamsters as controls and 2 of each sex as the experimental ones. Group A was treated with a 10% concentration extract, while group B with 5% and group C with 1% concentration. The extract was administered after a period of acclimation of thirty consecutive days. Food and water consumed by all organisms were carefully recorded and daily weights were also recorded.

These same tests were performed again with concentrations of 2.4g/100ml of distilled water and 1.4g/100ml of distilled water, in which the weight of the specimen wed was recorded.

New tests were performed to study the behavior under the effects of the mushroom. They consisted in running the habitrail express.

Histological sections were made of kidney, brain, testicles, lungs, intestines, heart and liver. Only brain and testicles showed some damage. All tests were repeated using *Mus musculus*.

The extract was chromatographically analyzed and the Rf values were obtained and compared with the ones obtained by J. Ott and G. Guzmán. The presence of two hallucinogenic substances was determined: psilocin and psilocybin. Psilocybin is unlawfully used as a hallucinogen in Florida.

*Fourth Award - General Motors ISEF/Behavioral and Social Sciences
Honorable Mention - American Psychological Association

AGE SHIFTS IN CEREBRAL HEMISPHERE DOMINANCE - A SECOND YEAR STUDY -

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My project is based on a theory stating that each hemisphere of the human brain can do certain tasks better than the other hemisphere.

Last year's hypothesis was that cerebral hemisphere dominance exists and correlates with human traits. This year's hypothesis is that cerebral hemisphere dominance changes with age and that correlations between physical, mental, and emotional traits and cerebral dominance also change with age.

Last year's experiment was conducted using a 20-question questionnaire I developed and gave to 450 8th grade students. Nine questions were to determine hemisphere dominance and 11 questions were on human traits. This year I expanded last year's questionnaire into a 100-question questionnaire. Eighteen questions were to ascertain cerebral hemisphere dominance and the remaining questions were to reveal interesting trait correlations. I sent out 4000 questionnaires to 2nd, 6th, 9th and 12th grade students. A modified 20-question questionnaire was given to the 2nd grade students.

The raw data entry, statistical processing, and information organization and formatting were done on my computer via programs of my own design.

Using statistical techniques including the null hypothesis I determined that hemisphere dominance does change with age. Using correlation coefficients I determined mental and emotional traits correlate with hemisphere dominance and do change with age, but most physical traits have no statistically significant correlation with either hemisphere dominance or age.

#A STUDY OF FETAL AUDITORY IMPRINTING IN COLINUS VIRGINIANUS (QUAIL)

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All of the habits and abilities one has were once obtained through learning. Imprinting is a type of learning that takes place in the earliest stages of life, and, perhaps the medium through which the most crucial capabilities are acquired. Extensive research has been done on visual imprinting. This study explores the effects and significance of fetal auditory imprinting during and after the critical period (sensitive period in which imprinting occurs).

It was hypothesized that when a quail (Colinus virginianus) embryo was exposed to a sound it would be imprinted to this sound and the responses toward this sound would be greater during the critical period than after.

The specimens were divided into four groups exposed to these sounds: 1. a control, exposed to no sound 2. downy woodpecker sound 3. sound produced by an audio oscillator 4. a predatorial sound. When they hatched, their locomotor responses were tested in a variety of tests and recorded.

It was concluded that the hypothesis was correct in that the specimens were auditorially imprinted in the fetal stage;however, the locomotor responses declined after the critical period only in some cases.

This research is significant to numerous areas. Among these are human prenatal imprinting (including the ability to test hearing at early ages and the alteration of speech and behavior patterns) and the preservation of endangered species. This research also constitutes studies such as instinct vs. imprinting, and the effects of the critical period on all learning.

#Second Award - General Motors ISEF/Behavioral and Social Sciences

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OLFACTORY AND CHROMATIC SAVOR

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Out of all the senses taste is the least informative. A blindfolded person with a cold cannot tell the difference between orange juice and grapefruit juice. Thus, the organ of taste, the tongue, relies upon the senses of smell and sight to identify the substance it is tasting. This three year experiment was designed to determine the effect color and smell create on the sense of taste. Individuals were tested on an one-to-one basis, with a simple process, utilizing sucker pieces, blindfolds, and sucker flavoring. The results were then correlated with sex and age. The first year, by coloring suckers a different color than the accepted flavor color, it was found that color does affect what one may believe the the flavor to be. In addition, it was determined that the ability to taste peaks at the age of 11, and on an average females appear to taste with more reliability than males. In year two, it was evident that taste is a sense that can be improved, and rely more on the actual taste and not outside influences. This experiment was conducted using sucker pieces of a variety of flavors and a pre-test and post-test situation. The age group with the highest improvement in tasting ability was also the 11 year olds. The third year revealed that smell also greatly influences the flavor that one may believe food to be. his experiment was conducted by giving a blindfolded individual a flavored sucker piece and then placing a scent below their nose as they tasted. In each experiment controls were established for comparison and analyzation.

#WHAT CONDITIONS CAN AFFECT HUMAN REACTION TIME?

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The purpose of this project is to observe the effects that certain stimuli have on the central nervous system, and to make the public aware of what certain stimuli can do to their reaction time. This was accomplished by placing a yard stick next to the ball of a subject's foot. A marble was then dropped from different heights. When the subject couldn't move his foot before the ball hit it; a record was made of that distance. The distances were averaged. The averages of the inches the ball hit the subject were converted into hundredths of a second. Subjects were then exposed to various stimuli and the results were observed and recorded.

The results of this project were the following: Phase I, it was observed that males reaction time were faster on an average that female and children were faster than adults. In Phase II, it was observed that on an average alcohol in any form slows human reaction time. In Phase III, it was observed that classical music had the least effect on reaction time, while hard rock increased reaction time the most. The results of Phase IV, showed that exercise improves reaction time of males ages 13-15, after 10 and 20 minutes, but after 30 minutes the reaction time begins to decrease.

The hypothesis of this year's science project is based on the belief that caffeine in soft drink form will slow or speed up human reaction time. The results of Phase V showed that on the average caffeine improves human reaction time, in amounts of 2 liter of cola with caffeine.

#Second Award - Federal Aviation Administration

# OPTIMUM AD PLACEMENT DUE TO NATURAL OPTIC MOVEMENT

Holly Ann Heckman
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The intent of this experiment involves the placement of advertisements in such a manner that the advertiser can control the portion of the page that is seen at the initial exposure to that page, and to determine what effect the size of the object holds.

The most important factorsinvolved in this experiment were the method of experimentation and the analysis of data collected. Tests were conducted by making twelve pages of different planned patterns of circles with a variation in the size of the item in the Ideal Spot, which was determined in previous experiments. The subjects were then asked to casually analyze these pages, one at a time. Then because readership is determined by human response, the subjects were asked to recall the item they remembered seeing first. Analysis of collected data was then combined, by identifying all locations tested. Then, for each of the four patterns with three pages of size variations each, the items with the two highest readerships were circled. It was concluded that the size of the item in the Ideal Spot, overall, did not effect the readership response. It was observed, though, that it is possible for the pattern of the items to effect the majority margin of the spot by splitting the readership between the Ideal Spot and the item stressed in the pattern.

#Third Award - American Optometric Association and the Auxiliary to
the American Optometric Association
Third Award - American Psychological Association
Fourth Award - General Motors ISEF/Behavioral and Social Sciences

#INVESTIGATING THE CHRONOLOGICAL ACQUISITION OF VOCAL AND PHYSICAL BEHAVIOR PATTERNS - A FOUR YEAR STUDY OF ASPECTS OF COMMUNICATION AMONG RINGNECK PHEASANTS

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Communication, both vocal and physical, is a vital element in the many diversified events and activities of the numerous bird species. The previous three years of this research has revealed that the Ringneck Pheasant utilizes an intricate system of vocal and physical communication patterns. The purpose of this phase of study was to investigate the rate at which maturing Ringneck Pheasants develop the patterns of communication previously identified in mature birds, and to determine the influence of mature Ringneck Pheasants on this developmental process. Therefore, the vocal and physical development of the Ringneck Pheasant from birth to full maturity was recorded and observed, and the application of their communication system was examined under 12 isolated and grouped settings. Through a methodology, which incorporated the chi-square statistical analysis of null hypotheses, an additional 4200 minutes of recordings and numerous sonographic analyses, this phase of research validated that the acquisition of vocal communication patterns of this specific galliform are hereditary, and that there is no significant difference in the communication patterns of Ringneck Pheasants at nine weeks of development, and Ringneck Pheasants who have reached full maturity. It also was concluded from this phase of investigation that distinct vocalizations utilized by fully mature Ringneck Pheasants are demonstrated by Ringneck Pheasant chicks in the first week of development, therefore these birds can be sexed by the vocalizations they elicit in the time span prior to three weeks, which is when the physical characteristics of male and female Ringneck Pheasants are initially identifiable..pa

#First Award - American Veterinary Medical Association
First Award - General Motors ISEF/Behavioral and Social Sciences
First Award - Patent and Trademark Office/U.S. Department of Commerce/Patent and Trademark Office Society
First Award - U.S. Army
Second Award - American Psychological Association
Alternate to London International Youth Science Fortnight Trip - U.S. Army
Glenn T. Seaborg Nobel Prize Visit Award

#OBSERVATIONS OF THE SOCIAL AND INDIVIDUAL BEHAVIOURS OF ORANGUTANS

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The orangutan (pongo pygmaeus), an endangered species, is a relatively passive primate with a high level of intelligence and many human characteristics. My observations were done at the Metro Toronto Zoo where there are a group of eight orangutans. I have observed these primates each summer for the past four years, ranging from two weeks to one month of daily observations. During which time I have compiled more than six hundred hours worth of data.

Iobtained my data through a series of molar and molecular checklists monitoring the primates social and individual behavioural patterns. I as well used running diaries, observational periods, confidence-fear ratings and photographs in an effort to obtain additional information concerning their conduct within the group structure.

My purpose was to compare their behaviour in captivity with previous studies done in the wild, and to monitor the changes that occured in the group structure with the addition of new baby orangs in the group, as well as changes that might occur as the adolescent orangs mature. The results of my investigations were recorded through various graphs and sociograms monitoring specific dyadic behaviours. The orangs, who are largely solitary in the wild were found to form a stable social group in captivity.

#Honorable Mention - Eastman Kodak Company

COMPUTERS IN EDUCATION: PHASE II-OBSERVATION

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Computers in Education is a four-year study designed to resolve the major question raging in the field of education today: "Do students learn better with or without the computer?" The purpose of this year's observational phase is to videotape third-grade classrooms in order to determine how these students learn through an analysis of their behavior. The data gathered in this phase will be used to construct a program designed to maximize students' psychological interaction with the computer. In order to accomplish this, the behavior of the students in three third-grade classes was analyzed on a scale of zero to five in the categories of responsiveness, rambunctiousness, and attentiveness. These three scores were then combined to yield a total score for the taping period. The mean scores were: beginning of the day-10; middle of the day-11; and end of the day-12. These results illustrate that students generally learn better as the day progresses. Therefore, a computer-aided classroom should rely at first on the disciplinary skills of a human teacher, relinquishing more responsibilty to the computer as the day progresses. Key observational patterns of the students in this phase rebut the fallacy of some that the computer would have a damaging effect on the role of the teacher in the classroom. Rather, the machine would free the instructor from the tedious responsibilities of record-keeping and reinforcement, allowing her to fully experience the joy of teaching.

#THE EFFECTS OF THE FUNGUS PANEOLUS SPHINCTRINUS IN COMPARISON WITH THE EFFECTS OF THREE DRUGS UNKNOWN SUBSTITUTES IN THE HAMSTERS MESOCRICETUS AURATUS

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One of the fundamental events of the human being is the continuity and analisis of the events that are presented in our daily lives, this is how we did it in 1985-86, where we studied and analized the effects of "Paneolus Sphinctrinus" fungus in the Mesocricetus Auratus. The results were not very exact. Then we worned about analizing and comparing this substitute that so commonly young people use, with other drug substitutes; the "Mimosa Pudica L.", "Datura Arborea" flower, and "Banana Peel".

To be able to complete our study we divided the investigation in 2 areas; integrating one into the other. In the first phase we observed the primary and secundary effects of these substitutes in the Mesocricetus Auratus. In the phase we did some chemical test to determine what substance contained these drug substitutes.

#Third Award - General Motors ISEF/Behavioral and Social Sciences

#BREATHING FOR THE BRAIN

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PURPOSE: To test my hypothesis that people can better perform the task of creating a block design by stimulating the lateral right hemisphere using forced breathing. With this project I chose to examine if nasal breathing could be changed to meet the needs of creating certain block designs, a task completely related to right hemispheric activity.

PROCEDURE: When interviewing each person, I followed these steps:

1. Participants were first given a block design to create for practice.
2. I had them breathe onto a mirror to see which nostril created a greater pool of condensation.
3. I showed them a picture of the design to create and I timed them as they matched the puzzle with the picture.
4. I had them use forced breathing for five minutes to try to stimulate the other hemisphere.
5. I again tested them with the mirror and gave them another design of equal difficulty to create as I timed them once more.

RESULTS: Eighty percent of the people changed nostril dominance through forced breathing. Twenty percent of the people could not change within a five minute period. All of the people who did alter could stimulate the right hemisphere to better perform the task of putting block design puzzles together.

APPLICATIONS: In an era dominated by drugs and high-tech scanners, it would be ironic if so simple a procedure as altering our breathing patterns could give temporary relief from moodiness or madness. Breathing exercises could also be used to better perform our daily activities.
#First Award - American Psychological Association

#DOES LETTER CONFIGURATION AFFECT ASSIMILATION: A THREE YEAR STUDY

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Does the shape of lower case letters affect the speed at which letters are learned? Will recognition of letter groups classified according to ease of identification show correlation to the above?

Kindergarten test results were compiled from one hundred ninety students to determine the rate at which each lower case letter was learned. The lowest percentage of lower case letters learned were letters of similar appearance. Letters known by 50%-75% of the students had similar shapes, yet distinctive characteristics. Commonly seen letters (o,s,x,) were known by 76%-100% of the students.

To test my hypothesis, a test was developed composed of letters put into groups based on ease of identification and the number of students who could identify them. Sets of letters were shown for three seconds. Students were to circle the matching group of letters on their papers.

When comparing individual letter assimilation to letter-group recognition, the range of differences was significant for each of the groups tested. Follow-through was noted from Kg. to 1st grade and Kg. to 3rd grade. Male-female differences were noted in the 370 testings.

The results indicate the importance of having children recognize and learn the distinctive characteristics and differences in letters both visually and mentally before attempting a reading program. Such learning would start with word configurations of the more distinguishable letters.
#Third Award - General Motors ISEF/Behavioral and Social Sciences
Honorable Mention - American Psychological Association

EFFECTS OF TYPE OF HOME ENVIRONMENT ON BEHAVIOR

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High school seniors from a small, rural community in the southeastern part of the U.S. completed questionnaires designed to determine the manner of upbringing and type of behavior patterns exhibited. Subjects were placed into one of three categories (restrictive or conservative, average, or unrestrictive or liberal) based on responses to basic criteria. The responses to various parameters were tallied for the members of each of the three groups. The liberal group was found to exhibit more liberal and unrestrained behavior than either of the other two groups, while the conservative group exhibited more restrained behavior than either of the other two groups. Many of the differences were significant and some were highly significant. Males were less restricted at home than females. White females were the most restricted group. A single profile of a typical high school student could not be constructed because of the great differences found to exist between four groups of students -- black males, black females, white males, and white females. Profiles were constructed for each of these four groups. The most important parameters investigated pertained to sexual experience and practice; freedom and practice of drinking, smoking, and use of marijuana and harder drugs; punishments used and required at home, school, and in the community, freedom and practice of use of leisure time; church membership and religious beliefs; and plans for education and work.

#SOCIAL BEHAVIOR OF THE GROSBEAK STARLING (Scissirostrum dubium) AT THE MINNESOTA ZOO

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ABSTRACT. Twelve grosbeak starlings (Scissirostrum dubium), three adult pairs, two juvenile pairs and two single juvenile males, were observed in the Tropics Building at the Minnesota Zoo over a 20 week period. Prior to the study grosbeak documentation in scientific literature was nearly non-existent. The ad lib, focal pair/individual and instantaneous methods were used to compile 150 hours, 40 minutes of data, each individual being observed 759 minutes (with the exception of one 693 minute male). This included 70 hours of preliminary research. During this time the grosbeak's entire behavior repertoire was categorized and defined. Categories of behavior observed during the 20 weeks included agonistic, sexual, affiliative, comfort, investigative, ingestive, vocalization, locomotive, nesting and eliminative behaviors. The main objectives of the research were to categorize grosbeak behavior, and to ascertain the environmental and behavioral parameters affecting reproductive success. Sexual and related behaviors were low during the research possibly due to time of year, and low population density. Grosbeaks are extremely social as indicated by their high intraspecific interactions and ability to repair within a few days. Without proper visual, vocal and physical interactions, sexual and related behaviors will be low. This, along with low humidity levels, frequent human interactions and low population density appeared to be the major factors influencing low reproductive success during the study. Dominant-subordinate relationships, particularly one pair harassing another was an additional stress on reproductive success, and is in part due to small intraspecies populations. It seems that reproductive success would increase if these parameters were improved.

#First Award - General Motors ISEF/Behavioral and Social Sciences
Honorable Mention - American Psychological Association

#ACQUISITION OF CONCEPT FORMATION BY SEQUENTIAL SYMBOLIC MATCHING-TO-SAMPLE

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The purpose of this original experiment was to investigate the interdependence of "same" and "different" in the acquisition of concept formation. No procedure reported in the animal learning literature (that is used to study concept formation) demonstrates that pigeons are capable of learning the "same"-"different" concept. The methods used in previous studies do not rule out the possibility that animals were just learning a simple stimulus matching problem as opposed to an actual concept. The procedure employed 3 subjects in an operant conditioning chamber (by the method of successive approximations) to peck three keys. Following the shaping, the subjects were exposed to a symbolic matching-to-sample procedure to teach them the concept. Each bird was presented with a different pair of stimuli. The middle key displayed a pair of sequential stimuli which signaled reinforcement would be contingent upon next pecking the left key (representing "same") or pecking the right key (representing "different"). Since no distinctive stimuli appeared on the side keys, the animals could not have pecked the correct key unless they were discriminating a concept (not a stimulus pair).
The three birds exhibited acquisition above the chance (50%) level. Two of the birds clearly demonstrated generalization of the "same"-"different" concept when exposed to novel stimuli not used in the training. The practical importance of this study is developing effective methods of teaching concept formation to the developmentally disabled by minimizing errors in the learning process.

#Fourth Award - General Motors ISEF/Behavioral and Social Sciences

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#PSYCHOPHYSIOLOGICAL RESPONSE PATTERNS TO STRESS IN HIGH SCHOOL STUDENTS -- A 2-YEAR STUDY

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Approximately 75% of all medical complaints are stress related. Thus, an important health care concern is learning to control the ever-mounting stress present in people's lives. Random surveys conducted over a two-year period at urban and rural high schools in Ohio and Japan indicate that high school students are as susceptible to stress and stress related problems and diseases as adults -- every student surveyed responded that stress was an integral part of his life. Moreover, surveys taken monthly by forty selected students revealed that stressful situations vary according to a number of factors, such as time of year, grade level and the student's sex; monthly surveys also indicated that students deal with stress in different ways. Most importantly, these surveys reinforce the fact that it is not the stressor that causes stress, but rather the way the mind perceives the stressor.

Biofeedback, a technique for the mastery of psychogenic stress, measures stress indexes such as changes in muscle tension, skin temperature or skin resistance. In order to actually measure responses to stress, ten students were randomly selected to undergo a series of stress-inducing tests such as mental math, anticipation and spontaneous noise while monitored by a biofeedback device. The students were then made aware of relaxation techniques and retested. This retesting resulted in lowered stress response levels. Thus, by mastering stress-reducing techniques, an individual can gain control of his physiological functioning and thereby master his internal control systems in effective stress management.

#Fourth Award - General Motors ISEF/Behavioral and Social Sciences
Honorable Mention - American Psychological Association

ORGANIZATION OF COLOR BY INTERNATIONAL AND AMERICAN STUDENTS

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The purpose of my study was to determine if there are differences between ways international and American elementary school students perceive and organize color and identify these differences if they exist. The basic device used was 56 color cards with different color swatches on one side and a code number on the reverse. For four weeks, several second, fourth, fifth, and sixth grade classrooms were visited. Fifty-four students were asked to complete the task. Thirty-two American students and 22 international students were included in the study. Students were asked to place the cards into "color groups." This open-ended question was interpreted in many ways. Notes were taken recording such variables as the groups into which students put the cards, time taken to complete the task, identifying characteristics of students such as age, sex, country and origin, and any unusual procedures used to complete the task.

Analysis of the results consisted of Pearson product-moment correlations, chi-squares, and simple percentages. All calculations focused on differences between international and American students. International students averaged 19 groups as opposed to 11 groups by American students. A significant Pearson correlation between years lived in the United States and the number of groups was obtained. The incidence of non-conventional procedures also was quite varied between American and international students.

Results suggest marked differences between how international and American students perceive and organize color. In general, the international students displayed more sophistication and diversity of organization than the American students.

ADAPTING A PERSONAL COMPUTER FOR EDUCATIONAL USE WITH A MENTALLY HANDICAPPED PERSON

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The project "Adapting A Personal Computer for Educational Use With A Mentally Handicapped Person" involves the development and application of a educational peripheral for a Personal Computer.

The experimenter designed this educational device to be used with his severely mentally retarded sister (Stephanie). The materials and programing are tailored to Stephanie's skills and abilities. A special keyboard, consisting of four push button switches, was designed to accomodate her fine motor skills. This device was interfaced to the computer using an analog to the digital converter card. The programing materials that accompany the keyboard device were developed from interviews with Stephanie's teachers and Dr. Sarah Litch (an educational consultant).

The programing was organized into "lessons" by subject matter. A "lesson" asked Stephanie to do tasks of related subject matter. Stephanie's performance on the individual lessons was recorded to demonstrate the project's potential as an educational tool.

The educational device has been effective in increasing Stephanie's attention span, and concentration levels. However, at this time Stephanie has demonstrated no substantial improvement on materials related to reading skills.

The educational peripheral is adaptable to most individuals through appropriate programing.

CREATIVITY: ENVIRONMENT OR GENETICS

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Creativity is a mental process that allows one to use original thought effectively. While most people are creative, experts did prove that "right-brained" thinkers are more adept at using creative thought beneficially. While right-brained people are known for their self-motivation, experts are not sure whether these people cultivater their creativity without outside stimulation. This experiment asks the question: Is creativity a product of genetics or the environment?

The hypothesis states that creativity is a product of one's genetic background. To prove this statement, a standardized right/left hemisphere test was administered to a group of one hundred ninety-five students and their parents. Of those tested, nineteen percent fall in the right-brained category. These thirty seven students were given a "creativity survey", which was devised with the assistance from Reba Meador, coordinator of the gifted/talented program in Bartlesville. From these results, a conclusion was drawn as to the validity of the hypothesis.

The results disprove the hypothesis. Most students responded that their environment played a major role in their creative development. Both parent and student replied that the home/family environment did not affect creativity as much as individual cultivation.

EFFECTS OF CAFFEINE AND LACK OF SLEEP ON LEARNING

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No abstract received.

THE RELATIONSHIP BETWEEN MUSICAL TALENT AND THE ABILITY TO PLAY THE LIGHT/SOUND GAME SIMON

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This project will attempt to determine the validity of the following assumptions concerning the light/sound sequence game, "Simon".

(1) For students who have no musical experience, the sound makes no difference in their success.

(2) There is a difference in success levels between musically trained students and students without musical training.

(3) The sound affects the performance of a musically experienced student.

(4) If the sound is turned off there is no difference between the success levels of musically trained students and those with no musical training.

Using a class of tenth grade students, with and without musical experience, a series of experiments with a modified Simon was performed as follows. Eighteen students with an average of four years of musical experience each, were asked to play Simon ten times. (Five times with the sound on, and five times with sound off.) Seven other students without any past musical experience were also asked to play, under the same conditions.

A comparison of these results form the basis of the answers to the proposed questions.

DO BIORYTHMS CORRELATE WITH PHYSICAL AND INTELLECTUAL FLUXUATIONS?

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The purpose for studying biorythms is to determine if they have any scientific basis and what practical purpose they can serve. Biorythms are calculated by using the relationship between the time of a person's birth and the lunar cycle. Tests were run on students and results were compared with their biorythm charts. It was found there was a direct correlation between the fluxuations in the results and the charts. With further study, biorythms could become widely used in medicine, businesses, and high risk jobs. They also are said to be used to predict the sex of babies and natural deaths. I hope to be able to show these practical uses to be worthwhile and accurate.

NUMBER CONCEPT IN RATS

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This experiment was based on the work of Edward Chace Tolman,who stated that the learning that takes place in a rat's brain forms a cognitive "map." If motivation and frustration are too great, the rat will use the "strip map" and gather limited information. The rat, using the "comprehensive map," uses a more generalized view to receive stimuli, and it selects only what is important to learning.

The purpose of this experiment was to demonstrate that a rat, using the "comprehensive map," can learn the human skill of number concept.

A young, grey-hooded, male rat was nurtured for five days, then placed in a glass-covered holding area of a training box that symbolized Sign-Gestalt Expectation. There were three swinging doors with dots ranging from one to three. Each door led to a corridor, but the reward was always behind the door with two dots referred to as Door Two. The location was changed; then, the patterns were changed from dots to squares to triangles until the rat consistently chose Door Two.

After six weeks and five sessions each week, the rat went through Door Two on the first attempt regardless of location or design. The rat made a total of 750 attempts and entered Door Two 385 times on the first attempt. The rat entered Door Two on the first attempt 24% the first week, 58% the second week, 31% the third week, 57% the fourth week, 68% the fifth week, and 87% the sixth week.

In conclusion, it was demonstrated that a rat, using the "comprehensive map" to gather information about the stimuli, and being motivated by the expectation of reward, can learn number concept, which is thought to be a human skill.

THE PSYCHOLOGY OF CHILDREN'S ART

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Because of a personal interest in art and psychological tests using art, I decided to find an area of this subject that I could research. I read *The Psychology of Children's Art* by Rhonda Kellogg and Scott O'dell. With this information, I went out into my community and gathered several pictures drawn by young children. These children were of various ages and of different family backgrounds. I also observed a variety of personality types in these children. I reviewed their drawings and compared them to the ones in the book by Kellogg and O'dell.

The results of my project showed that children who have not been taught to draw, draw in the same way. All children follow basic drawing patterns at certain levels and ages.

THE EFFECT OF LIGHT UPON THE CONDITIONING OF RATTUS RATTUS

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The purpose of my investigation was to learn the effect of light upon the conditioning of rats.

I tested the hypothesis that if a rat is subjected to constant light, its learning ability will be lower than a that of a rat who is subjected to constant darkness.

To test their learning ability, each rat was put into a controlled home environment, one in constant darkness and one in constant light. The rats were then deprived of water for a period of 20-24 hours. After this deprivation period, each rat was put into a manually operated Skinner box for a ten minute training period. Here the neutral stimulus which was the clicking of a bar, was paired with the unconditional stimulus, which was the water reinforcement. This where the rats became classically and operantly conditioned. After their training sessions, the rats were put back into their home environments where they recieved free water for a 2 hour period.

From this it was learned that the rat in the dark environment had a better learning ability than did the rat in the light environment. This was true because the stress put upon the rat in the light environment. Further investigations, with 2 new subjects, are also proving conclusive.

STUDY OF ALCOHOLIC RATUS RATUS AND ALTERATION OF AGGRESSIVE BEHAVIOR

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Aggressive behavior patterns and the sequence of events that will occur when two strange adult rats (Ratus ratus) meet on neutral grounds was studied. Alteration of behavior due to alcohol consumption was also recorded. Identification of alcohol preferring rats provided subjects for intensive study. Pulse, weight, general appearance, and behavior were observed. It was concluded that alcoholic rats suffer withdrawl and the same symptoms as humans.

#SENSORY PERCEPTION IN CAMBARIS BARTONI AND ICTATURUS PUNCTATUS

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While completing research, I determined that fishes develop rings on their inner ears and the rings can be attributed to learning. By using control and experimental groups, I determined that fishes that had been subjected to learning activities developed more and better-defined rings. From the experimentations, I devised an IQ gauge for continued research. A use for this process was devised . From my research, I discovered that catfish and crayfish farms suffer from large kills because the animals do not have the intelligence to cope with environmental changes. Methods were devised to teach fishes and crayfishes. The location of rings and the number of rings added were determined from my experimentations. Juvenile hormones in insects were researched. Juvenile hormones from male moths were centrifuged and applied to antennae and antennules on the crayfish. Juvenile hormones caused an increase in the regeneration of the antennae of the crayfish.

#First Award - U.S. Navy
Second Award - General Motors ISEF/Behavioral and Social Sciences
Honorable Mention - American Psychological Association

A STUDY OF STRESS-CAUSING FACTORS & RESPONSES TO THESE FACTORS AMONG TEENAGERS IN NORMAN COUNTY, MN COMPARED BY AGE AND SEX

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Stress has a great impact on teenagers today. The purpose of this investigation was to determine the most common causes of stress in teenagers, to find the activities chosen most frequently to release this stress, and to compare the differences in their responses on the bases of age and sex.

The data was collected by the use of a written survey given to a total of 650 students in grades 7-12 in five schools.

Students taking the surveys were asked to rate each of the potential stress causes listed on the survey by assigning it a number from 1 to 6 according to how much stress they felt that it caused them. The surveys were divided into four groups to make it possible to compare the responses of the different sexes and age groups. An average stress rating for each of the potential causes was then found for each group.

The students were asked to choose three activities that they most often use to release stress. The surveys were again divided into the same four groups, and the percentage of the number of times each one was chosen in relation to the others was found.

It was found that the factors that caused teenagers the most stress dealt with school, such as academic achievement, taking tests, homework, and teachers. Factors receiving very low stress ratings included drinking, drug use, and employers.

The activities chosen the most often to release stress include music, spending time alone, talking to a friend, and television respectively.

A TWO YEAR STUDY OF BRAIN CHANGES IN MICE SUBJECTED TO CONTRASTING ENVIRONMENTAL CONDITIONS

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Does environment determine the brain size and learning capacity of an organism? An attempt to answer this question was started in the previous year's study. It was found that environment does play a role in brain size of 30-60 day old mice.

In the current research I attempted to determine if the environment of the mother has an effect on pups prior to and for three weeks after birth. Also if this effect is seen in aged mice. Another variable in the study was the effects of light vs. absence of light.

Mice were set up in twelve environmental conditons. Enriched young with and without light, normal with and without light, deprived with and without light, and old in identical situations.

Brains of each animal were removed after sacrificing, weighed, and and sectioned for cortical depth study.

It was found by using a student t-Test that environment does significantly increase brain size and cortical depth in enriched environment. Light was found to be insignificant as was age in increasing brain weight. However, age does seem to effect cortical consistancy by causing a disintegration of cortical tissue.

CAN WORMS LEARN

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The purpose of this experiment was to attempt Pavlovian conditioning in earthworms (Lumbricus terrestris). The conditioned stimulus, vibrations from a buzzer, was presented to the earthworms and was joined four seconds later by a bright light, the unconditioned stimulus. Both stimuli ended simultaneously two seconds after the light was presented. A group being observed for random motion and a group being observed for response to the buzzer alone were controls. After several trials, usually from about seventy to eighty, the worms in the experimental group developed conditioned responses to the buzzer before the presentation of the light. Thus Pavlovian conditioning with a light as the unconditioned stimulus and vibrations as the conditioned stimulus is possible in earthworms.

DOES AGE AFFECT REFERENTIAL COMMUNICATION ABILITIES IN CHILDREN?

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This study was designed to test the hypothesis that referential communication abilities increase with age. 10 subjects from each of grades 2, 4, 6 and 8 were asked to perform 3 tasks. First, they were to explain the game "Simon Says" to someone who had never played the game before. The next task required them to instruct first a four year old, and then an adult, how to make a peanut butter and jelly sandwich. Lastly, the children were asked to describe an abstract figure to someone who could not see it, but would like to draw it. Each task was scored separately. When the results were compared, it was found that there were small increases in scores among grades 2, 4 and 6, and a much,much larger increase in scores was found between the grade 6 and 8 levels. This pattern was clearly visible in the results from all three tasks.

#DIPLACUSIS: INTERAURAL DIFFERENCES IN PITCH PERCEPTION

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A test series was devised to measure the interaural differences in pitch perception of human subjects at four square wave tones between 300 Hz and 2400 Hz. Square waves were selected because they are closer to the sounds of music than pure tones. In the tests the subject repeatedly adjusts and compares a variable pitch tone played by a headset to the right ear until it matches the pitch of a constant reference tone that is played to the left ear. The two tones can never be heard simultaneously. One series of tests consisted of three pitch matchings at each of four frequencies spaced one octave apart. An IBM PCjr computer running software that I had programmed in Pascal generated the two tones; switched the signal between the two ears upon demand; and stored the results in a database, along with pertinent information about the subject's age, sex, and type and amount of musical ear training.

Preliminary results indicate that the pitch matching consistency directly depends on the amount of ear training, concentration, and fatigue. Subjects with ear training obtained repeatable results, and these showed diplacusis of a few percent or less. One subject, for example, matched a 1200 Hz tone three times in a row with a 1205 Hz tone, showing that diplacusis amounts to 5 Hz for this subject at that frequency. Plans for continued research are to investigate the effect of short term training, influence of the type of ear training and music preference, and subjects' age on the amount and repeatability of diplacusis.

#Fourth Award - General Motors ISEF/Behavioral and Social Sciences

#SELF-REFERENCE AND EGOCENTRICITY

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A sample of thirty students were asked to speak during an interval of five minutes about a previously chosen, neutral topic. The total number of words spoken, the total number of self-references spoken and the total number of other-references were recorded for each subject's sample of speech. A fourth variable was designed as the ratio of self-references to other-references. These four variables were correlated with each student's average score on an egocentricity questionnaire. It was found that none of the four pairs of variables studied produced a very strong coefficient of correlation. However, the line graphs that were plotted indicated that there were characterisitic profiles, to which the majority of subjects conformed.

#Fourth Award - General Motors ISEF/Behavioral and Social Sciences

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#AN ENTHNOLOGICAL STUDY OF THE LOSS OF CULTURE AMONG THE BLACKFEET INDIANS

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Interviews were conducted with enrolled members of the Blackfeet Indian Nation in Glacier County Montana. The Blackfeet Indian Reservation is the third largest Indian reservationin land mass with 1,462640 square acres in the United States of America. It is estimated that the state of Rhode Island could fit into this reservation three times. The interviews mentioned in the beginning deal with traditional and tribal life styles past and present. Questionaires dealing with abstract cultural entities were also administered. In addition, traditional Indian clothing was worn and comments were recoded.

Information was obtained dealing with actual Indian views and the view of Indian sterotypes of the non Indian community. Some of the topics included views on alcoholism, unemployment, education, tradition, and lifestyles, both past and present.

This study showed that there is a great loss of the Blackfeet culture. Also that the culture was not just lost over night or within the last fifty years but has been a gradual loss beginning with the first contact the Blackfeet had with the whiteman over 200 years ago. Further young Indian students show a great apathy toward their culture and do not wish to revive it.

#First Award - American Indian Science and Engineering Society

#THE INFLUENCE OF TESTOSTERONE ON THE SOCIAL HIERARCHY OF *MUS MUSCULUS*

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The concept of dominance has been studied since 1922, but little is known about the determinants of dominance in the individual. In order to determine if testosterone could alter an existing social hierarchy, 18 sexually mature, male mice were randomly assigned to one of three experimental groups and pretested for dominance and related physical traits and skills. One experimental group was given 50 mcg of testosterone, the second 25 mcg, and the control group only oil for 10 days. Dominance-related behavior was observed during the period of injection. Following the injections all tests were repeated. Changes in the dominance hierarchy and other traits were calculated and statistically analysed. Results showed a 330% increase in all scores for mice receiving 50 mcg compared to 130.1% for those receiving 25 mcg, and 108% for the control group. Significant differences between the means of the control group and the group receiving 50 mcg occured in 9 of 13 tests, and 5 of 13 between the control group and the group receiving 25 mcg. It is clear that an established hierarchy can be artificially altered by large doses of testosterone.

#Third Award - General Motors ISEF/Behavioral and Social Sciences
Honorable Mention - American Psychological Association

LEFT/RIGHT BRAIN - IS THERE A DIFFERENCE?

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Can one hemisphere of our brain be dominant? Will this affect our physical and mental functioning?

I administered a test to 140 people based on functions, actions and feelings believed to be centered in the left or right side of the brain. These results were compared with handedness, eye dominance, folded hand position, foot dominance, writing posture, etc.

My results showed a definate preference for eye dominance, handedness, hand posture and in other areas for most of my subjects. The preference outcome of the paper test was noted on a scale of 1-9 with 1-4.9 showing left brain dominance; 5.1-9 indicating right brain dominance. A difference was noted in scores of males versus females. When comparing the paper test to the activities, the activities' results were 88% in the left hemisphere while the paper results on feelings, etc. were 76% in the left hemisphere of the brain. I found correlation between chosen occupations and hemisphere dominance.

These findings can be used to promote interaction of more than one hemisphere of the brain to enhance life or to improve performance in school, hospitals, offices, armed forces, etc.

#IS COLOR PERCEPTION AFFECTED BY AGE AND SEX?

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I began my project with the hypothesis that color perception is affected by age and sex. To find if my hypothesis was true, I devised an experiment in which dilute dye solution was added to a glass of water. The dilute dye solution has a ratio of one cubic centimeter of food coloring to 450 centimeters of water. The colors used were green, blue, red and yellow. A person seated two feet from the glass was asked if they could see a color. The number of drops needed for each person to see each color was recorded. My data seemed to show that people under 18 perceived color at about the same rate. Males and females 18 and older had a harder time perceiving color than people under 18, but this difference was more pronounced in males. Red was the hardest color for people under 18 to see, while green was the hardest color for people 18 and older to see. Yellow was the easiest color for all groups to perceive.

This data seems to indicate that as people grow older their ability to perceive color decreases, although color perception in males seems to decrease at a greater rate. Since it is pigments in the cones of the eye that absorb light waves, my data might indicate that as people grow older their cones deteriorate.

#Honorable Mention - Federal Aviation Administration

SEQUENTIAL MEMORY: CAN STUDENTS REMEMBER SEQUENCES OF LETTERS, NUMBERS, OR SYMBOLS MORE EASILY?

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PROBLEM: Which can students remember more easily: Sequences of letters, numbers, or symbols?

PROCEDURE: On the 1st day students in K-12 grades were shown sequences of letters, numbers and symbols for 2 minutes each then told to write down the sequences they remembered. Two days later they were shown the same 3 sequences for 30 seconds and told to write down what they remembered. The Kindergarten and 1st grade students were given cards to arrange in the proper sequences.

RESULTS: In this project 824 students from grades K-12 were tested twice. Overall students displayed better short term and long term memory skills in the Number Sequence. They did poorest in the Symbol Sequence. The serial function graphs showed strong primacy and weaker recency effects. The mean, mode, median, and standard deviation were also determined for each grade. Comparisons between last year's 1 minute test and this year's 2 minute and 30 second tests for grades 9-12 showed the benefits of previous exposure on the 30 second test. Based on these findings, if a teacher presents new material one day and then waits and reviews it with a fourth of the original time 2 days later, students should be able to recall most of the original information.

BIOCHEMISTRY

KARYOTYPING OF MURINE EMBRYONAL CARCINOMA CELL LINES

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Murine embryonal carcinoma (EC) cells offer a unique model system for the examination of gene regulation during differentiation and development of the early mammalian embryo. They have many common characteristics with embryonal stem cells. Most important of these characteristics to our studies is the fact that there is a blockage of viral gene expression in both systems. However, taking advantage of new recombinant DNA technology, rare clonal EC cell lines that carry and express the integrated neomycin-resistance (neo) gene flanked by the Moloney-Murine Leukemia Viral Terminal Repeat (Mo-MuLV LTR) have been isolated. Molecular analyses have revealed that this retroviral integration has yielded a deletion of the 5' LTR sequence of the proviral genome. The basic intent of this research was to study the cell lines of the chromosome level. It is concluded from this research that this molecular deletion is less than a 1.5 Kb deletion. Moreover, these findings disprove the belief that EC cell lines have a normal karyotype. It is also interesting to note that most of the observed rearrangements involved chromosomes carrying an oncogene, which is believed to be one of the underlying factors of neoplastic change.

#CAROTENE AND RIBOFLAVIN

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Auxin is known to be the cause of phototropism, but the light receptor pigment which causes the auxin transfer is not known. The two most probable pigments are carotene and riboflavin. If phototropism occurs in UV light, then riboflavin is the more likely light receptor pigment, since it does absorb light in the UV region of the spectrum, while carotene does not. The amounts of carotene and riboflavin on the light and dark sides give some idea about which pigment may be acting with or on the auxin, which is known to accumulate on the dark side of plants.

Several techniques were used:
1) The degree of phototropism especially in the near ultraviolet range, where the absorption spectrum of carotene and riboflavin differ.
2) The amounts of carotene on the dark side and the light side were also measured and compared, using chemical separatory techniques and spectroscopy.
3) The amounts of riboflavin on the dark and light sides were compared by splitting the coleoptiles lengthwise, and using chromatography and riboflavin's ability to fluoresce.

The degree of phototropism in UV light and the differences in the amount of carotene and riboflavin on the dark and light sides both will indicate the light receptor pigment for auxin.

#London International Youth Science Fortnight Trip - U.S. Navy
Fourth Award - General Motors ISEF/Biochemistry

#ISOLATION AND CHARACTERIZATION OF SMALL EXTRACHROMOSOMAL CIRCULAR DNAS: THEIR RELATIONSHIP TO DEVELOPMENT AND AGING

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Eucaryotic cells contain small extrachromosomal circular (ecc) DNA molecules which can be separated from chromosomal DNA. These molecules are similar to the extrachromosomal elements (plasmids) found in bacteria, but unlike bacterial plasmids, their cellular functions remain a mystery. These circles share some of the same sequences found in chromosomal DNA. The circle sequences are repeated in eucaryotic genomes, and appear to be transposable elements involved in genetic rearrangements. My studies were initiated to determine if eccDNAs could be used as markers to follow mammalian development and aging. I have isolated eccDNAs from brain, heart, and liver tissues of C57B1/6 mice of various ages. The DNA was purified by alkaline denaturation-renaturation and equilibrium density gradient centrifugation. Enzymatic analyses of the purified DNA from the equilibrium gradients confirmed the circular nature of these molecules. The gradient fractions were hybridized with radioactive probes of the mouse genome (B1, B2, R, and MIF dispersed repetitive sequence families). I have found sequences in these circular molecules which are homologous to the major repetitive sequence families of rodents. I have demonstrated that these families of repetitive sequences were represented in brain, heart, and liver eccDNAs. The quantity of these sequences varied with the tissue and changed with age. The results indicated that the genetic information in higher cells can change during aging or development. This age-related variation in repetitive sequences that I have discovered might be a characteristic property of the molecular mechanisms involved with development and aging.

#Fourth Award - General Motors ISEF/Biochemistry

THE EFFECT OF ANTIHYPERTENSIVE AGENTS ON ANF LEVELS IN SPONTANEOUSLY HYPERTENSIVE *RATTUS NORVEGICUS*: PHASE II

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A recently discovered hormone, atrial natriuretic factor (ANF), has been reported to cause a natriuretic and diuretic effect as well as a relaxation of vascular smooth muscle. The objectives were to determine the amount of ANF present in spontaneously hypertensive rats (SHR) compared to normotensive animals and to determine the effect of antihypertensive agents on ANF levels in SHRs. Four groups of six were used: a Sprague-Dawley control and three SHR groups - a control, enalapril (Vasotec), and nifedipine (Procardia). After two weeks, blood pressure was measured and atrial extracts were purified. ANF levels were measured by urine sodium, potassium, chloride, and volume measurements. Bioassays and blood pressure determinations were done. Data was analyzed using a student T-test and analysis of variance with a Scheffe post-hoc pairwise comparison. Blood pressure of the four groups consisted of a very significant ($p<0.01$) increased level of SHRs and a very significant decrease in the nifedipine group compared to controls. A very significant diuretic effect occurred from SHR extracts compared to controls and from nifedipine extracts compared to enalapril atrial extracts. The data suggests that nifedipine increased stored ANF levels, possibly because of its mechanism of action. It was concluded that SHRs contain higher stored ANF levels than normotensive animals, possibly because of a functional disorder of the atria or an overproduction of ANF. ANF affects many systems of the body including the excretory, circulatory, and cardiovascular systems. Learning more about ANF and its effects could provide better insight and treatment of related diseases such as kidney failure, cardiovascular disease, and hypertension.

#THE POSSIBLE USE OF PROGESTERONE IN EMBRYOTIC DIAGNOSIS UTILIZING MAGNETIC RESONANCE IMAGING (MRI)

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MRI (Magnetic Resonance Imaging) is a technique using magnetic waves to diagnose human structures and chemical systems. However, this technology cannot be used in viewing embryos, because embryo movement blurs images as they are produced. The purpose of this project was to test a particular chemical which may slow down embryo metabolism, and thus movement. From my research, the female hormone, progesterone, was a candidate for testing.

Progesterone was chosen based on three primary characteristics: 1) it is a natural-occuring hormone in females; 2) it has been used as an aneasthetic; and 3) as an aneasthetic, it has a fast recovery time. My hypothesis was that progesterone would slow embryotic metabolism.

To test my hypothesis, embryos were removed from their shells and placed in plastic bags. Progesterone was injected into the 96 hour-old chicks. Then, the embryos' heartrates were calculated via sonogram imaging equipment. Since the progesterone was suspended in sesame oil, another group of embryos were given sesame oil injections. A final group had no injections given.

The results showed that progesterone injections lowered embryotic heartrates more than the sesame oil injections and no injections by 18% and 43%, respectively. From these results, I concluded that progesterone slows down the metabolism of chick embryos.

Future work will consist of continued experiments with chick embryos. Eventually, I hope to develop a technique of using progesterone for human use. With a method of slowing down embryos metabolism, MRI will allow us to detect birth defects in earlier stages and gain a greater understanding of the chemical development of embryos.

#Grand First Award - Patent and Trademark Office/U.S. Department of Commerce/Patent and Trademark Office Society
Fourth Award - General Motors ISEF/Biochemistry

#WHAT ARE COMPOSITES?

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Research was conducted to investigate and determine the possibility of making a paper product from waste vegetable and fruit matter. The first test used to achieve this goal was to take one cup of carrot skins and place them along with one liter of water in a blender. After breaking up the fibers in the blender they were pored into a paper mold. The next step was to remove the fibers from the mold and place them between two screens and press to extract the moisture held by the fibers. The final step was to remove the fibers from the screens and place them between two blotter papers where they were pressed and placed in a press for final drying. Several tests followed in which the same basic process was followed. The only alteration in each test was the type of vegetable or fruit ingredient used. In certain tests different vegetable fibers were mixed with other vegetable and fruit fibers. In other tests fruit fibers were mixed with other fruit fibers. While still other tests mixed wood pulp paper fibers with different vegetable and fruit fibers. Each test proved to yield a new and uniquely different paper product. The bonding of the different fibers is refered to as a composite. A composite being that which is composed or made up of parts. The studies demonstrated that paper products could be produced from waste vegetable and fruit matter, thus reducing the amount of wood needed to meet ever increasing paper demands, creating a means of using our garbage, and produce a new market for vegetable and fruit growers.

#Honorable Mention - American Chemical Society

DIFFERENTIATION OF CULTURED RAT LEUKEMIA CELLS INDUCED BY CHEMICALS

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Differentiation is the process by which myeloid leukemia cells can develop into nondividing, mature cells instead of remaining trapped at an immature stage and continually reproducing. Four chemicals, 5-azacytidine, L-ethionine, dimethyl sulfoxide, and sodium butyrate, which have been proven effective in inducing differentiation in other cell lines, were tested at various concentrations for their effects on the differentiation of C-51 rat leukemia cells. The amount of differentiation induced by those chemicals was determined by measuring morphological and biochemical changes in the cells which occur upon differentiation. Cells were assayed for colony formation in soft agar in the presence and absence of chemicals, and growth curves were performed on cells in suspension culture. Cells were cultured for three days and then subjected to soft agar assay to determine their state of differentiation, and lysozyme assays were performed on the cells after they had been cultured in the presence of chemicals for four days. The results of this investigation indicate that 5-azacytidine can induce the differentiation of C-51 cells, but the amount of differentiation induced is limited. The other chemicals tested do not seem to be able to induce C-51 cells to differentiate as effectively as 5-azacytidine, although some seem to be able to inhibit the proliferation of the C-51 cell line. The results of this project seem to suggest that this line of research is quite promising, and the discovery of an effective chemical inducer could prove most beneficial to leukemia and cancer research and treatment.

#PARA-CHLOROPHENYLALANINE EFFECT ON AGGRESSION OF RATTUS NORVEGICUS

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This project was designed to determine the effect of para-chlorophenylalanine on the aggression of laboratory rats. Para-chlorophenylalanine was chosen because its effect is manifested through grawing by the rat which is easily observed and because of its solubility. The subjects were housed in separate plastic cages measuring 57cm x 35cm x 24cm with metal tops. Food and water were available at all times. The subjects were divided into four groups of five each. A dowell rod measuring 20cm long and with a diameter of 1cm was placed in each cage. After five days, the length of the rod was measured and initial tendencies to gnaw were recorded. One gram of para-chlorophenylalanine was received from Sigma Chemical Company and dissolved in 200cc of normal saline. A series of three injections was given. First group A received 0.25cc normal saline, and groups B, C, and D received a 5mg/kg of body weight injection of para-chlorophenylalanine. With the second injection groups A and B received 0.25cc normal saline and groups C and D received 10mg/kg of body weight of para-chlorophenylalanine. Finally, groups A, B, and C received 0.25cc normal saline and group D received 15mg/kg of body weight of para-chlorophenylalanine. New dowell rods were placed in each cage.
Thirty minutes after each injection, an electric shock of 130 volts was given and latency to gnaw and time spent gnawing were recorded. It was observed that increased doses of para-chlorophenylalanine had a direct effect on the aggression of laboratory rats as manifested in gnawing. Three days later, dowell rods were measured and it was observed that the effect of the chemical remained after a three day period.

#First Award - U.S. Air Force

#SCREENING MONOCLONALS FOR THEIR TARGETED ANTIGEN: FACTOR VII

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Factor VII is a blood coagulation protein about which little is known. It is thought to be a new therapeutic alternative for hemophilia A patients with possible applications to other blood disorders. The purpose of this project is to screen monoclonal antibodies (McAbs) for their targeted antigen, Factor VII.

An enzyme linked immunoabsorbent assay (ELISA) was performed using a microtiter plate coated with partially purified Factor VII. Added to selected microtiter columns were (1) milk in phosphate buffered saline, (2) mouse conditioned media, (3) mouse ascites, or (4) rabbit serum. Mouse McAbs received rabbit anti-mouse immunoglobulins while rabbit polyclonals received swine anti-rabbit immunoglobulins. These immunoglobulins were horseradish peroxidase conjugated. Using OPD as a color reagent, the microELISA reader measured the amount of Factor VII at an absorbance of 490 nm. From sodium dodecyl sulfate polyacrylamide gel electrophoresis, two solutions each of 7.5% separating gel and 3.0% stacking gel were made and polymerized. Based on molecular size, samples of partially purified Factor VII were electrophoresed. One gel dried; the second was exposed to the Western blot method which included driving the gel protein into a nitrocellulose sheet. The sheet was cut into 5 strips to test each of the solutions in the microtiter plate.

The color change in the nitrocellulose sheet isolated the gel band for Factor VII indicating that the screened McAbs were indeed for Factor VII. By utilizing the characteristic of McAbs to "zero in" on their targeted antigen, more information can be discovered about Factor VII. This result gives optimism in expanding the limited research on Factor VII as it relates to hemophilia A and certain blood disorders.

#Third Award - General Motors ISEF/Biochemistry

#INVESTIGATION OF THE MECHANISM OF *S*-ADENOSYL-L-METHIONINE HYDROLASE

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The mechanism of the reaction in which *S*-Adenosyl-L-methionine hydrolase (SAMase) cleaves *S*-Adenosyl-L-methionine (SAM) was investigated. SAM is an important molecule in all living systems and its principle function is to donate methyl groups in biological reactions, such as modification of host DNA. SAMase occurs when *E. coli* bacteria is infected by T3 bacteriophage. The cleavage of SAM prevents its activated methyl group from being donated. The goal of this project was to find the mechanism of SAMase.

The mechanism of the reaction was investigated by analyzing one of the products of the enzymatic cleavage, homoserine, for its stereospecific configuration i.e. the positioning of its atoms, specifically at the 4-carbon. The reaction procedure involved feeding various stereospecifically deuterium labelled derivatives of SAM, specifically 4,4-dideuterated, 4*S*-, and 4*R*-SAM, to the isolated enzyme and examining the protons of the homoserine product by ^{1}H-NMR spectroscopy to note any changes in configuration. It was discovered that the 4-carbon undergoes an inversion of configuration. Thus it was concluded that the mechanism involves an S_N2 reaction, wherein some group (either water or the carboxylic group of SAM) attacks the 4-carbon adjacent to the sulfonium atom.

This conclusion might help in understanding the importance of SAMase to T3 bacteriophage, especially considering that SAMase does not occur with any other bacteriophage.

#Honorable Mention - American Chemical Society

THE EFFECT OF HNO_3 AND CH_3COOH ON THE LEGUMINOSAE PLANT

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An experimental study was performed to determine the effects of two(2) different chemical substances on plant growth. This researcher used two(2) different solutions each with five(5) different molar concentrations of HNO^3 (nitric acid) and CH^3COOH (acetic acid) to find, of the ten(10) concentrations, which solution and more specifically which concentrations would effect the growth pattern of the Leguminosae (bean) Plant as compared to a distilled water solution control group. On January 1, 1987, this researcher planted thirty-six(36) Leguminosae seeds (Blue-Lake Bush Beans), three(3) seeds in twelve(12) seperate pots. Then this researcher used a 1.0 molar concentration of both Nitric and Acetic acids by diluting them with distilled water (pure H^2O) down to: .1;.01;.001;.0001;.00001; which were used as the plants only source of liquid food (which is usually water and/or fertilizer). These concentrations and controlled solutions were applied eight(8) seperate times, twenty(20) milliliters of each of the two concentrations and solutions were added to each of the plants in the twelve(12) different groups. This researcher then tested the pH of the soil both before and after each application on: January 1, January 3, January 7, January 9, January 11, January 15, and January 17; then this researcher performed many different test (explained later) on each solution and concentration, including pH of all solutions then proceeded to observe the effects of the experiment, calculate the observations, and record and chart all final results of the entire experiment. This researcher has determined that Acetic acid grew the plants faster with the ratio of 3:1 against the Nitric acid, which is used in commercial and household fertilizers.

COMPARATIVE ELECTROPHORETIC ANALYSIS OF DIGESTION IN THREE INSECTS

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The problem was to study the distribution of digestive enzymes in adults of the American cockroach, *Periplaneta americana*, and to use electrophoresis to separate enzymes involved in digestion of protein and carbohydrate in the cockroach, and two other insects, teh yellow meal worm, *Tenebrio*, and the carpet beetle, *Attagenus*. Intestinal tracts were dissected from adults of the cockroach. They were divided into 5 regions: (1) salivary glands; (2) crop; (3) proventriculus; (4) midgut; and (5) hindgut. Extracts of each region were prepared and tested for enzyme activity. Protease activity was found mainly in the midgut and hindgut. Amylase activity was present mainly in the midgut, salivary glands, and crop. Sucrase activity was most active in the crop and midgut. The results demonstrated that different enzymes are located in different regions of the intestive and that digestion of different nutrients occurs in different regions of the intestive.
Enzymes involved in digestion in the cockroach, mealworm, and carpet beetle were separated by electrophoresis on polyacrylamide gels. Enzyme activity on the gels was detected by using zymogram techniques with starch as substrate for amylase and casein as substrate for protease. In the roach, one distinct amylase band was found in the salivary glands, while the crop and midgut had 4 light bands each. Four protease bands were found in the crop and midgut and no bands were found in the salivary glands. The carpet beetles had the most protease bands and 2 distinct bands of amylase activity. Mealworm had several amylase bands but they were not completely separated. The results indicated that the three species were different in enzyme composition.

#THE IDENTIFICATION OF UREAPLASMA UREALYTICUM

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The purpose of this investigation is to identify the 14 serovars of **Ureaplasma urealyticum** by clusters using zymogram analysis. **U. urealyticum,** the smallest self-replicating organism known, is often a pathogen of human urogenital infections as well as certain autoimmune system disorders. Using various techniques, serovars 1,3,6, and 14 have been known to comprise cluster A, while the rest, except for serovar 13, comprise cluster B. The zymogram analysis was based on the electrophoretic mobility patterns of the inorganic pyrophosphatase, urease, and diaphorase of the 14 serovars. Cell-free extracts of each of the 14 serovars were prepared from the organisms grown in a horse serum medium. Proteins of these extracts were standardized and separated electrophoretically on a gel. Enzyme activities were visualized on the gel using staining systems activated in the presence of final products. Silver staining and comassie blue R staining techniques were used to obtain general protein profiles of the 14 serovars. The results of the inorganic pyrophosphatase assay allowed the precise identification of the 14 serovars by clusters, including serovar 13 which was, for the first time, identified as a cluster B serovar. The zymogram analysis of other enzymes, as well as the protein profiles, generally supported the presence of two clusters among the 14 serovars. The results obtained from this study are significant in that they provided additional parameters in identifying pathogenic clinical isolates by clusters. Moreover, this investigation yielded information useful in studying the taxonomic characteristics of **Ureaplasma urealyticum,** as well as the evolutionary relationships between this organism and other Mycoplasmas.

#Third Award - General Motors ISEF/Biochemistry

CHEMICAL CONTROL OF RHIZOBIUM LEGUMINOSARUM

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The purpose of my project is to study the effects of various herbicides, pesticides, and fungicides on the nitrogen-fixing bacteria, Rhizobium leguminosarum.

I hypothesized that the control would allow proper conditions for many more colonies of R. leguminosarum to develop. Secondly, I hypothesized that the herbicides, pesticides, and fungicides would negatively affect the growth of R. leguminosarum resulting in considerably lower colonies of bacteria present.

For my procedure, I researched the topics that are covered and collected materials needed to complete the project. I collected data using the following method. The bacteria was grown in media of mannitol nutrient broth test tubes which contained a 0.2% concentration of the selected chemical. These were, after 24 hrs. of incubation, plated by means of the pour plate method. This method is done by taking one loopful of each mixture and adding it to a sterile petri dish along with 20 ml. of sterile mannitol nutrient agar. Total plate counts were made after 24 hrs. of incubation and growth with a standard ruled bacteria colony counting plate. For a control, 50 test tubes were inoculated with bacteria, but no chemical was added. Three types of each chemcial were done, 25 for each type, for a total of 275 petri dishes.

I concluded, pesticides, herbicides, and fungicides had an effect on the R. leguminosarum. The control had higher colony counts than any of the chemicals tested. The fungicides had the most adverse effect on the growth of the R. leguminosarum. The pesticides and herbicides had approximately the same final averages.

#HOW LONG DO MATERNAL ANTIBODIES EXIST IN CHICKENS?

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Maternal antibodies are the antibodies an offspring receives from its parents through its mother. The purpose of this research was three fold: to determine if maternal antibodies of various diseases found in poultry are passed to the baby chick from its parents, to determine the length of time a chick's antibody levels are at a high enough level to offer the chick a substantial amount of protection, and to determine the length of time the chick will be protected with maternal antibodies before vaccinations must be given to insure its immunity to disease.

Fifty, day-old chicks were obtained. Blood samples were drawn from three chicks every other day from day one to day twenty-six. The blood serum was analyzed for antibodies against four specific disease viruses using the Enzyme Linked Immunosorbent Assay System. The four disease virus antibody levels being monitored were: Newcastle Disease Virus, Infectious Bronchitis Virus, Infectious Bursal Disease Virus, and Reovirus.

The researcher found that after nine days the chicks did not have sufficient antibody levels to protect them from Reovirus and Bronchitis. After eleven days of age the chicks were unprotected against Bursal and Newcastle. This means that if there were to be an outbreak of one of these viruses the flock would be susceptible, resulting in the entire flock being destroyed in order to avoid the risk of further contamination. Since protection would be necessary at this point, the optimum age for vaccination against those four potentially lethal diseases is around nine days of age since the innoculation is given as a multiple vaccine.

#First Award - American Veterinary Medical Association

EFFECT OF HEAVY METALS ON THE SPECIFICITY OF RESTRICTION ENDONUCLEASES

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A restriction endonuclease is a bacteria's natural defense mechanism against viruses. It recognizes specific sequences within double-stranded DNA called palindromes. Since heavy metals affect the three-dimensional shape of proteins, there is a high-probability that heavy metals will also affect the function of restriction endonuclease which recognise palindromes as specific cleavage points.

To test this hypothesis, EcoR I endonuclease was tested for cleavage points on lambda phage DNA. The restriction endonuclease EcoR I is known to cut lambda at the cleavage site GAATTC.
CTTAAG

EcoR I was tested under control conditions to obtain a pattern of cleavage using agarose gel electrophoresis. The DNA in the agarose gel was made visible by the fluorescent dye, ethidium bromide. This substance intercalates between the bases of DNA and fluoresces in ultraviolet light. The experiment was repeated after assaying the restriction endonuclease with cadmium chloride, mercuric chloride, ferric chloride, and zinc chloride at 10^{-3} M. When the restriction endonuclease was assayed with the heavy metals, only mercuric chloride altered the recognition sites of the enzyme. It was questioned whether mercuric chloride would alter the enzyme's specificity when assayed with lower concentrations which would better mimic the concentrations found in the environment. Lesser concentrations of the metal also altered the recognition sites of EcoR I at 10^{-4} M. and 10^{-5} M. for Lambda DNA. This also caused the fragments of digested DNA to differ from the controls.

HYPERVITAMINOSIS A IN THREE CONSECUTIVE GENERATIONS OF *RATTUS NORVEGICUS* PHASE III: ANALYSIS OF TISSUE ATROPHY AND CHORMOSOMAL MUTATION

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Research in phases I and II demonstrated a metabolic variation in the third generation of *Rattus norvegicus* in the hypervitaminotic state. The objective of phase III was to further validate this claim, which entails conducting more exhaustive histopathological analysis than had been conducted in phases I and II, and including cytogenetic analysis as well. Because all metabolic pathways are ultimately under genetic control, and given the results of previous research by the author, it is hypothesized that the observed metabolic evolution is genetic in origin.

To test this hypothesis, the researcher developed three generations of *Rattus norvegicus*, using two separate groups: a control group and a hypervitaminotic group. The diets of each group were consistent for each generation throughout the research. Upon the maturation of the third generation, the researcher utilized standard histopathologic and cytogenetic analysis to more closely observe the effect of this altered metabolism on tissue and chromosomal morphology.

In collecting data from these analyses for phase III, the researcher collaborated with Dr. Alison Bendele, a pathologist, and Mr. Jamie Brunny, a toxicologist, both of Eli Lilly and Company, Greenfield. Both Dr. Bendele and Mr. Brunny provided professional supervision and advice.

Histopathological analysis supports the claim of altered metabolism, in that by generation three, the common tissue atrophy was no longer present. Preliminary cytogenetic analysis has proved inconclusive in determining a specific abberation causing the altered metabolism; however, research continues, searching for its genetic origin.

#SODIUM TRANSPORT STUDIES OF THE *EX VIVO* PERFUSED RAT KIDNEY BY NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

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The exact mechanisms for sodium (Na^+) transport in the kidney is of great significance to the fields of renal physiology and clinical nephrology. Unfortunately, past methods did not involve the intact, functioning kidney. Nuclear Magnetic Resonance (NMR) spectroscopy is be used to provide qualitative and often quantitative information about various magnetically dipolar nuclides, such as Na-23. The present study attempted to develop a technique that employed Na-23 NMR spectroscopy to monitor Na^+ transport in the functioning rat kidney. A paramagnetic chemical shift reagent was used to distinguish Na^+ in various compartments. The physiological model used to study Na^+ transport was the *ex vivo* perfused rat kidney. Perfusion of the right kidney was established via renal artery after surgical cannulation. Na-23 NMR spectroscopic studies were then performed. The data obtained from the experiments conducted indicate the presence of separate resonance frequencies from renal tubular, vascular and interstitial, and possibly intracellular Na^+. The individual resonance frequencies of Na^+ in these various compartments are probably due to unique shift reagent to Na^+ ratios. These results are significant, in that they may be used as a basis for the development of experimental and clinical applications of NMR spectroscopy for monitoring renal Na^+ transport mechanisms.

#First Award - General Motors ISEF/Biochemistry
First Award - U. S. Army
Third Award - American Chemical Society

#THE EFFECTS OF ULTRAVIOLET RADIATION ON THE PRESERVATION OF FOOD: AN INVESTIGATION USING KIRLIAN PHOTOGRAPHY.

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The purpose of this investigation is to determine the effects of ultraviolet rays on the preservation of food and the effectiveness of Kirlian photography in the determination of these effects.

The researcher hypothesized that ultraviolet radiation would have an effect on food preservation and that this effect could be detected through the use of Kirlian photography. The researcher also included a null hypothesis that stated that she believed that exposure to ultraviolet light would not affect the preservation of food, and therefore it could not be tested using Kirlian photography.

The researcher tested three experimental groups. These were: a group left unrefrigerated and untreated by ultraviolet light, a group left unrefrigerated but exposed to the light, and a group that was both refrigerated and exposed to radiation. The control group was under normal refrigeration and was not exposed to the UV light. The groups were tested using Kirlian photography, a spectrophotometer, and a microscope.

The researcher has concluded that ultraviolet radiation has a positive effect on food preservation and that Kirlian photography is an effective method of determining the freshness of food products. The researcher's results were statistically significant at a .01 confidence level, which means that she is 99% sure that her observations were not a result of chance.

#First Award - Eastman Kodak Company

EFFECTS OF GLUCOSE AND PHOSPHOGENS ON MUSCLE CONTRACTIONS

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These experiments were performed to determine which of the high energy phosphogens (ATP, ADP, AMP, or creatine phosphate) or glucose was the most efficient in providing the direct energy needed for muscle contractions. The phosphogen and glycolytic inhibitors (2-4 Dinitrophenol Ouabain, Vanadium, and Na-iodacetate) were tested to determine which one would most effectively block the muscle contraction. The muscle fibers were teased with probes under a dissecting microscope. The length of the five muscle fibers were measured before and after the application of each solution. The average percent of contraction, standard deviation, and standard error of mean were calculated from the measurements.

It was concluded from these experimental results that ATP, the most direct source of energy for muscle contractions, is most effective in providing energy for muscle contractions. The other phosphogens produced only slight contractions. They were necessary for providing a source of energy for the formation of ATP. All tested inhibitors were found to reduce the percentage of contraction in the muscles. Of the three inhibitors (Ouabain, Vanadium, and 2-4 Dinitrophenol), Ouabain was the most effective in preventing ATP from causing a very large contraction. It reduced the muscle contraction by 19.27% at 40 mM ATP while Vanadium and 2-4 Dinitrophenol lessened the contraction by only about 12%. However, the other phosphogens and glucose that were tested with the inhibitors had such minute contractions without the inhibitors that the effects of the inhibitors were not certain to be significant.

#First Award - U.S. Navy

IDENTIFYING THE AMINO ACIDS PRODUCED BY E. COLI: PHASE I

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Incomplete soy proteins are often used as meat substitutes. However, it has been found that if methionine is added to textured soy protein, the protein can be used by the human body in the same way as complete protein. If *Escherichia coli* could be found to produce methionine, it could be a relatively simple and economical source of methionine.

In Phase I *E. coli* was grown on both nutrient and gelatin agars and ten amino acids were identified, including methionine.

Phase I left some unanswered questions. 1.) Did *E. coli* actually produce the amino acids or did it break them down from proteins in the agar? 2.) Was methionine really one of the amino acids identified and if so, in what concentration? The hypothesis was that *E. coli* would produce amino acids and that one of them would be methionine. To answer these questions a protein free, liquid medium containing all of the necessary elements for amino acid synthesis was used. Pure amino acid samples were tested using paper chromatography for comparison. Column chromatography was used to separate amino acdis.

Seven amino acids identified in Phase I were also identified in this project. Methionine was identified in each test group. *E. coli* does produce amino acids and methionine is one of the amino acids. The amino acids identified are phenylalanine, aspartic acid, leucine, isoleucine, methionine, glycine, and serine. The final phase of this project was to determine the concentration of methionine produced. A Welch ChemAnal Monochromator was used to construct a Beer's Law graph. *E. coli* was found to produce methionine in the concentration of 1.87×10^{-4}M in one eluted fraction and 0.62×10^{-4}M in the other eluted fraction.

THE EFFECTS OF SULFITES ON THE GROWTH OF ESCHERICHIA COLI

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Sulfites have been extensively used as preservatives because of their positive effects on food. Some effects are control of enzymatic and non-enzymatic browning, anti-microbial effects (depending on the microorganism), dough conditioning, anti-oxidant actions, and bleaching. Additionally, sulfites are used as cosmetic additives to improve the physical appearance of the product. Sulfites keep food with good appearance and high nutritional value.

Sulfites had been considered safe, but recently, adverse reactions, such as asthma, diarrhea and hives, have been attributed to sulfite ingestion by sulfite-sensitive asthmatics. So far, seventeen (17) deaths have been connected with sulfite ingestion.

The purpose of this investigation is to find a relationship, if any, between sulfite concentration and the growth of *Escherichia coli*, a bacteria that inhabits the intestinal tract. An abnormal growth of *E.coli* may result in diarrhea.

The procedure used was: 1)two groups were formed: control(no sulfites) and experimental(varying concentrations 50ppm, 100ppm, 500ppm, 1,000ppm); 2)Petri plates with different sulfite concentrations were cultivated with *E.coli*; 3)after 48 hours, the bacteria colonies were counted and the bacteria present were totalized. The X^2, regression, correlation coefficient, and t-test analyses were performed to determine what kind of relationship, if any, exists between sulfite concentration and *E.coli* growth.

The statistical tests revealed that a positive and linear relationship (significant at $p \leq .01$)exists. Furthermore, for higher sulfite concentrations, a larger bacterial growth was obtained. This relationship may explain why sulfites cause diarrhea in sulfite-sensitive individuals.

#ANABOLIC STEROIDS: EFFECTS ON MALE MICE

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The effect of anabolic steroids on male mice was evaluated by measures of weight gain, muscle cell area increase, and area per nucleus ratios. Every 3 days for 18 days, 48 mice were weighed, exercised for 90 sec. on a treadmill at 0.5m/sec., then injected with either testosterone 17B cypionate (TC), testosterone propionate(TP), a combination of the two(TCP), or no steroid. The injections were given subcutaneously in the dorsal cervical skin fold. The steroids were given in corn oil vehicle(10mg/ml) at a final dosage of 40mg/kg; controls received the same dosage of pure corn oil. All mice were sacrificed by induced hypoxia on day 19. Step serial H&E cross-sections of the gastrocnemius muscles were quantitatively evaluated for cell area and area per nucleus using a morphometric digitizer(MOP). Data was analysed using ANOVA at the 0.05 level.

Weight gains were not significantly different between groups. TC mice showed the largest weight increase at 18.7%, TCP mice increased 14.7%, while TP mice were approximately equal to controls at 10.2%.

TP cell areas were significantly larger than other groups, but no other groups were significantly different. All area per nucleus comparisons were significantly different except for TC to TCP: TP was largest, control was smallest.

Evaluation of this data presents TC as having the greatest effect on rate of weight gain, while TP has a greater effect on cell hypertrophy (cell area and area per nucleus data). This suggests that the two steroids work through different pathways, supported by the medial values received for TCP.

#Fourth Award - General Motors ISEF/Biochemistry

# ELECTROPHYSIOLOGICAL CHANGES IN LOLIGO ACTION POTENTIAL

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The objective of this experiment was to determine if a specific concentration of Micrurus fulvious venom causes total blockage of impulse along the giant axon of loligo. In addition, the purpose was to discover whether filtered saline solution is capable of reversing the neurotoxic effects of venom on the axon. For use in electrophysiological research it is necessary for the loligo axon to be capable of conducting an electrical stimulus through a non-conductive medium. To assure that the degeneration of the action potential is minimized, the pleural nerves must be removed from the squid and placed in saline solution prior to or immediately following death. The direct current stimulus was provided by an adjustable power supply. The control voltage was experimentally determined to be 0.4 volts to prevent the death of the axon from over-stimulation. The stimulation was applied to one end of the axon by silver wire electrodes and received by silver electrodes at the opposite end. The response stimulus was measured by an amplified cathode ray oscilloscope. Micrurus fulvious venom was applied in varying concentrations beginning with a 0.0005% venom to water solution. Experimental results concluded that total inhabition of action potential occurs between 0.0001% and 0.000125% venom to water concentrations. Observations also revealed that saline solution restored partial or even total action potential to envenomed axon tissue over time.

#Fourth Award - General Motors ISEF/Biochemistry

#Hemoglobin Switching Across Vertabrate Glasses: Exchange of Developmental Signals by Cell Fusion

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My research investigate the molecular events that regulate developmental hemoglobin (Hb) switching. Recent reports indicate that *trans*-acting factors are involved in controlling different genes in specific cell types. In red cells, the *trans* factors may be globin gene-specific and/or developmental stage-specific.

The procedures used involve forming heterospecific polykaryons between erythroid cells from animals of different developmental stages, by cell fusion methods. The idea is that *trans* factors from an adult erythroid cell of an specie would thereby gain access to the fetal/larval nucleus of a second animal specie and trun on the adult globin gene in the fetal nucleus. The mRNA was detected by highly specific cDNA probes and hemoglobin synthesis was detected by native gel electrophoresis of the isotopically-labeled proteins.

Adult *Rana* globin genes are expressed in fusions involving mouse erythroleukemia (MEL) cells with *Rana* tadpole. It is concluded that the mechanisms and factors that regulate developmental Hb switching in vertebrates are highly conserved.

#Third Award - General Motors ISEF/Biochemistry

COMPARATIVE NEUROBIOLOGY IN *LUMBRICUS TERRESTRIS*

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No abstract received.

#EPA AND DHA: THE ESKIMO PARADOX

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Researchers have dicovered that Eskimos who eat a high fat diet appear to have a low incidence of heart disease and heart attacks. This finding is contrary to the belief that high fat diets increase the risk of heart disease and other related ailments. The reason for the lower incidence of heart disease appears to lie with eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) that are found in the seafood eaten by Eskimos. The objective of this experiment was to study the behavior of EPA and DHA and their interactions with cholesterol using monomolecular films to simulate a biological membrane. A Wilhelmy film balance was used to determine surface pressure-area isotherms for EPA, DHA, cholesterol, and stearic acid separately. Mixtures of cholesterol and DHA, as well as cholesterol and stearic acid, were studied to observe the interactions between these molecules. The stearic acid and cholesterol mixed monolayer was found to behave ideally in that the area per molecule is proportional to the mole fraction of cholesterol. A negative deviation from ideal behavior was observed in the mixed monolayer of DHA and cholesterol. The negative deviation could mean that DHA and cholesterol are miscible. This result might have a physiological significance in the control of cholesterol levels in the blood. Further work, however, is necessary to comprehend the effects of DHA and EPA on biological membranes.

#Second Award - American Chemical Society

EFFECTS OF THE LEONOTIS NEPETAEFOLIA AS A POSSIBLE CLOTTING AGENT OF BLOOD

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The purpose of this experiment was to determine the pharmacological capacity (blood coagulation) of the plant Leonotis nepetaefolia (Molinillo). To determine the coagulation effects extracts from the leaves, stems, seeds and roots at different concentrations were used.

The blood was extracted and collected in capillary tubes and then the time of coagulation was taken. This process was done individually. The average of all samples fluctuated between 4 and 8 minutes.

Blood samples were located in capillary tubes and treated with extracts of different parts of the plant at different concentrations.

Coagulation time before and after treatment was compared. It showed an average reduction of 50 to 30 seconds.

After several tests the extract from the seed showed the greatest reduction of coagulation time.

PH AND THE PRESENCE OF EARTHWORMS (PHASE 2)

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The purpose of this experiment is to determine if earthworms have any effect on soil pH. The hypothesis is the following: If earthworms are placed in soils of different pH, ranging from 5 to 9, then the soils will gradually become neutral. Experiment by placing 5 earthworms in each of 5 containers with a soil of different pH. Record changes in pH for valid number of days. The results show that pH 5, 6, and 7 changed to pH 6.4 as a result of the presence of earthworms, and pH 8 changed to pH 6.5. It is concluded that earthworms do affect the pH of soil. The hypothesis was proven partially correct. Although the presence of earthworms did alter the pH, it did not change to pH 7 (neutral) but instead to pH 6.4 and 6.5.

FREEZING ANGUILLULA ACETI WITH DMSO AND GLYCEROL IN DRY - ICE
SECOND YEAR STUDY

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The purpose of this second year study was to determine which cryoprotectants, DMSO (dimethyl sulfoxide) and glycerol, protects the vinegar from freezing to death. A cryoprotectant is a chemical that protects the vinegar eels from low temperature, such as dry ice and help them back alive.

I did two sets of experiment in this project. The first part, I used ethylene glycol and glycerol as my cryoprotectants against the low temperature of dry ice. In my results, I only went up through 3 minute time span. So, I did a second experiment on the vinegar eels with using DMSO (dimethyl sulfoxide) as my cryoprotectant. As I did this experiment, I had a longer time span than the first experiment. I started from 3 minutes and went through 12 minutes in addition to this experiment, I also used a solution called Heller's Solution, it contain (KCl, NaCl, $MgSO_4.7H_2o$, NaH_2PO_4, $CaCl_2$, versene #FE3, distilled water, Ph). This solution is added on the eels after its thawed up. Based on my experiment, I found out that DMSO works effectively in low temperature.

#IRRADIATION PRESERVATION: GAMMA RADIATION FOR FOOD PRESERVATION

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Irradiation has been proposed as a means to reduce food loses due to microbial and insect spoilage, improve the hygienic quality of food, reduce the levels of chemical food additives, and extend the shelf life of foods. This research will evaluate irradiation as an alternative or supplement to existing methods of food preservation. Chemical free bananas and potatoes were subjected to varying levels of ionizing radiation.Complete photographic diaries were maintained to visually compare test and control samples over spacific time intervals.Bananas irradiated at 40 Krads were found to be acceptable for further biochemical testing. Potatoes irradiated at 10 Krads showed sprout inhibition without undesirable softening of pulp or drying of skin.Biochemical analyses were performed on selected test samples to determine values, biochemical makeup, and possible radiolytic products.Assays included Bradford Coomassie for total protein;sugars;pH;TLC analysis of amino acids;and gel electrophoresis of protein.Results from these analyses strongly suggest a breakdown of proteins into amino acids and of complex sugars and starches into simple sugars. pH analyses showed a lowering of the pH in irradiated potato samples and no significant effect on banana samples. An investigation on sprout development and future generations of potatoes has begun with the planting of 1 Krad potato samples. Studies will continue to determine if exposure to selected levels of ionizing radiation will produce a more biologically stable food product and enhance food preservation while maintaining nutrient levels.

#First Award - Eastman Kodak Company
Second Award - Sigma Xi, The Scientific Research Society

FAT, CHOLESTEROL AND KILOCALORIES: CRITICAL FACTORS IN HUMAN HEALTH.

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The purpose of this project is to show that health conscious consumers can make responsible choices in selecting food from the meat group when based on accurate composition data. This study compared chicken, fish, pork, and beef. Fat and cholesterol tests were calculated on a dry weight basis. Removal of the moisture eliminates the possibility of possitively or negatively effecting the results.

Twelve beef samples were purchased from four retail stores. Three samples each of chicken, fish, and pork were also purchased. Portions of the beef samples were vacuum packed and frozen for a sensory panel. Samples for the fat and cholesterol tests were lyophilized with a freeze drier. All samples were analyzed for fat content (AOAC, 1984). Each sample was analyzed for cholesterol (Rheetal, 1982). Calories were also calculated.

This study found chicken and fish to contain a higher cholesterol and calorie level than the consumer is being told. I believe beef is one of the best sources of protein a person can buy. It is the most nutrient dense food in the meat group. The new exotic breeds such as the Chianina cattle will provide beef of low cholestrol and low fat content. In this study there was no significant difference in the juiciness, flavor, and overall quality compared to the beef consumers are now enjoying. Therefore, I believe a wise consumer should choose a "lite" beef.

#First Award - Vacuum Technology Division of the American Vacuum Society

THE CRITICAL CHEMORECEPTICAL ROLE IN FOOD-FINDING FOR *DUGESIA TIGRINA*.

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I am attempting to demonstrate the critical role of chemoreceptors in food-finding for animals which possess chemoreceptical tissue. I hypothesize that certain animals find food through chemicals in their environment and that damage to chemoreceptical cells will hinder the food-finding process of these animals.

I received and divided 40 planarians into four groups of ten planarians labelled OC-9C, OR-9R, OL-9L and OB-9B. I treated them equally until amputation. After anesthesis, I amputated the chemoreceptors on the right side of the head for the R Group, on the left for the L Group, and on both sides of the head for the B Group. I let them recover in their normal environment for 24 hours, not long enough to allow any regeneration. I placed food in each bowl and observed. Usually after 15 minutes, the chemicals had spread in the water and the animals began to react.

I noted that many R planarians spun to their left in the presence of food; many were unable to locate the egg yolk. Similarly, most L planarians spun to their right. C planarians (Control) found the food easily, while B planarians stayed motionless or moved haphazardly.

The hypothesis is upheld. The planarians with a damaged chemoreceptical side spun towards their intact side in the presence of food. With limited chemoreceptical abilities, many planarians were unable to find food which might have been needed for survival in nature.

A MICROSCOPIC ANALYSIS OF CHEMICALLY DAMAGED HAIR

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This project was designed to discover the effects of different chemicals on the structure of human hair. The hypothesis was that chemicals with bond breaking abilities will cause new structural shapes to develop when applied to human hair. To test this hypothesis, seven chemicals and seven hair types were collected. Among these chemicals were bleach, hydrogen peroxide, an alkaline cold wave permanent solution, a buffered ammonia permanent solution, a buffered thio permanent solution, an alphatine complex neutralizer, Agavo (a hair reconstructant), and hair dye containing ammonia. The hair types used varied in different textures, porosity, and previous chemical treatment. Sample A was brown, medium, normal, and untreated (virgin hair). Sample B was brown, medium, porous, and permed. Sample C was gray, medium, porous, and virgin hair. Sample D was brown, fine, very porous, and tinted. Sample E was dark brown, coarse, resistant, and virgin. Sample F was light brown, medium, porous, and sun, perm and chlorine damaged. Sample G was black, very fine, porous, and virgin hair. The seven chemicals were placed on each sample of hair while the relative temperatures and processing times were recorded. When this step was complete, all of the samples were observed under the microscope, drawn, and then photographed. A control of untreated hair samples was established to provide a comparison for the newly treated hair samples. The conclusion from this experiment was that these chemicals do cause new structural shapes in the hair but in varying degrees, thus supporting the hypothesis.

#INSULIN: 'A' CHAIN THAT LINKS MAN AND PROTOZOA
A FURTHER STUDY ON THE EFFECT OF INSULIN ON PARAMECIUM

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The effect of insulin on the reproduction of paramecium was studied. In my prior studies insulin was tentatively shown to increase the reproductive rate of paramecium. This present study significantly improves the methodology and adds new experiments to conclusively show that insulin does increase the rate of reproduction of paramecium. Paramecium multimicronucleatum were grown in small covered plastic containers at 20-24 degrees C, using spring water as the medium. Paramecium were counted using a disecting microscope 7X - 24X magnification. Insulin, both human and porcine, significantly increased the reproduction rate of paramecium in a dose dependent manner. Boiled insulin lost its stimulatory ability. Insulin showed this stimulatory effect when either rice or dilute glucose solutions were added to the medium. The alpha (A) chain of insulin seemed to have greater effect than the whole insulin or the beta (B) chain. Computerized literature searches and discussions with leading experts on insulin have confirmed the uniqueness of this study. My study shows that as in the human, the effect of the insulin is mediated through glucose. In contrast to the human, only the A chain of insulin is required for this effect. Most importantly this study shows for the very first time an important evolutionary link... a significant biological effect of a human protein hormone on a protozoa, in this case, paramecium.

#Third Award - General Motors ISEF/Biochemistry
Honorable Mention - American Chemical Society

#STRESS HORMONES ACTH AND CRF MAKE RATS GROOM EXCESSIVELY

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A study was established to better define the effect of intracerebroventricular (ICV) administration of corticotropin-releasing factor (CRF), on grooming behavior in rats and mice.

Male Sprague-Dawley rats were injected with CRF or vehicle and immediately placed in clean plexiglas cages. Specific behavioral categories were scored by a trained observer for a period of one hour, at fifteen-second intervals. Data analysis was performed on an Apple IIe computer using Visicalc, and statistical analysis of significance was determined by using ANOVA ($P<.05$). Results show that CRF affected not only total grooming, but also each subcategory of grooming, except for flank scratching. The minimum effective dose of CRF was found to be 300 ng, and a time course showed that CRF's effect on grooming was evident throughout the observation period. Similar studies conducted with mice showed no significant increases in grooming, suggesting a species difference in the sensitivity to CRF. Results also suggest that CRF-induced grooming is independent from its effects on the anterior pituitary-gland.

These findings support those of others suggesting that CRF located in the brain might mediate behavioral responses in stress. Learning what aspects of behavior are altered by agents such as CRF, broadens the understanding of the neurochemistry underlying normal behavior, improving the possibilities of future developments in psychiatric disorder treatments.

#Third Award - General Motors ISEF/Biochemistry

INVESTIGATIONS OF PHOTOSYNTHETIC ACTIVITY IN GREEN PLANTS

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Introduction: Photosynthesis is the process by which green (chlorophyll-bearing) plants manufacture glucose from carbon dioxide and water by chloroplasts utilizing light energy and oxygen gas. All our food and organic fuels come directly or indirectly from photosynthesis. Hypothesis: Through laboratory experimentation, it can be shown that photosynthetic activity in green plants is a complex series of events involving photochemical reactions, electron transport processes, and pigment absorption. Methodology: A series of experiments were performed to collect evidence that each of the above processes do occur and to investigate what role each of them play in photosynthesis. The data compiled was analyzed according to observations and thorough research. The majority of the experiments utilized water plants such as Elodea densa while others required the use of such land plants as Dieffenbachia. Conclusions: According to the results of of laboratory experimentations, I concluded that 1)in the photosynthetic reaction, carbon dioxide and water, in the presence of light chlorophyll,are converted to carbohydrates, oxygen, and newly constituted water; 2)Factors such as light intensity, temperature, and wavelengths directly effect the rate of photosynthesis in plants by either increasing or decreasing it; and 3)Radioactive materials can be used to trace the transport of organic compounds in plants. Applications: (1)As long as the process of photosynthesis continues, a constant supply of oxygen is maintained in the atmosphere, (2)Homes heated by combustion or coal are kept warm by the light energy trapped by the photosynthetic process in a carboniferous forest some 300 million years ago, and (3) energy obtained from glucose is used by living organisms to build new tissue.

A COMPARATIVE STUDY OF THE OMEGA - 3 FATTY ACIDS

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Recent research has uncovered a new hypothesis - prevention of heart disease by the increase of Omega-3 fatty acids in one's diet. Two Omega-3 fatty acids, eicosapentaenoic(EPA) and docosahexaenoic(DHA), have been found to lower the coagulation rate of blood and to lower the boiling point of the serum cholesterol in human arteries. These two factors are essential in the prevention of the arterial clumps and clots that cause heart attacks. Eicosapentaenoic acid in particular, is the raw material from which the body makes the chemical prostacyclin, a preventor of platelet(bloodcell)-clumping.

These two acids are found mainly in fish and vegetable oils of an unsaturated nature. The double bonds in the unsaturated oils lower the cholesterol's boiling point, making it more fluid and less prone to clotting.

Extracting these fatty acids from a variety of samples and identifying them and their quantity through gas chromatography, comparisons can be made amongst red meats, white meats, skins, fish meats, shellfish meat, and flower and vegetable oils. Results have displayed a larger amount of these two fatty acids are found in oysters, mackerel, salmon, scallops, olive oil and flower oils.

#EXTRACTION AND ANALYSIS OF MITOCHONDRIAL DNA

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The purpose of this study was to develop shorter methods for the extraction and analysis of small quantities of mitochondrial DNA (mtDNA). A particular sequence of ten base pairs in the D-loop region of porcine mtDNA has been observed to repeat. The shortened methods will be used to study the variation in the number of repeats of this sequence in different samples of mtDNA. Follicles and corpora lutea were cut from porcine ovaries and the cells were lysed. The mitochondria were then isolated by high-speed centrifugations. The DNA was extracted from the mitochondria and incubated with restriction endonucleases (RE) which cut the mtDNA at particular sites. The mtDNA was then subjected to electrophoresis on an agarose gel, and the fragments of mtDNA were observed. This project involved trying two basic methods to extract the mtDNA. The first involved separating the macromolecules of the mitochondria by electrophoresis on an agarose gel. When this mtDNA was reacted with RE and then again subjected to electrophoresis, the DNA remained uncut. Modifications to eliminate possible interference from the ethidium bromide stain were unsuccessful. It appeared that some other factor such as the agarose from the gel was inhibiting the RE digestion. The second method used to extract the mtDNA was a Phenol Extraction. mtDNA isolated by this method was cut by the RE, but smearing was observed on the gels. When Proteinase K and micrococcal nuclease were added to remove contamination, some sharp bands were visible on the gels. Further improvements in the mtDNA extraction procedures will enable future study of the ten-base pair repeating sequence as well as other research on mitochondrial DNA.

#Second Award - General Motors ISEF/Biochemistry

#SANGER SEQUENCING OF RAT IGF-I AT THE SITE OF THE NEWLY DISCOVERED POLYADENYLATED TAIL

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The purpose of this research was to discover the sight of the polyadenylated tail of the gene, rat IGF-I (insulin like growth factor I). Although the sequence of the rat IGF-I was recently published, the site of the polyadenylated tail had not been determined before this research occured.

Sequencing of the DNA (deoxyribonucleic acid) was done by the Sanger method of chemical sequencing. The DNA was first purified by repeated phenol-chloroform extraction, high-speed centrifugation, and ethanol precipitation. Once purified, the DNA was treated with a restriction endonuclease and divided into eight reactions (four forward and four reverse). Dideoxy/deoxy base mixes were added to the reactions with dideoxy A/deoxy A, G, T, and C being added to one aliquot, dideoxy C/deoxy A, C, G, and T being added to the next, etc. In each reaction, the radioactive dideoxy attached to the complement of the base for which is was prepared. Resulting DNA samples were run on polyacrylamide gel vertical electrophoresis. Films were exposed to the gel resulting radioactive exposure enabled the sequences to be determined.

The partial sequencing of the forward reaction in subclone 39 was found to contain the polyadenylated tail of rat IGF-I two base pairs before the end of the sequence.

#Fourth Award - General Motors ISEF/Biochemistry

THE EFFECTS OF CAFFEINE AND COFFEE EXTRACT ON THE HEPATIC DETOXIFICATION SYSTEM OF RATS

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A study of the effects of caffeine and coffee extract on the hepatic detoxification system of rats has been conducted. The detoxification system which consists of the microsomal cytochrome P-450 (phase I) and conjuagtion (phase II) enzymes could either activate or detoxificate xenobiotics into possible carcinogens. Three groups of three rats were intraperitoneally injected with caffeine and coffee extract (75 mg/ Kg body weight) for three days. Differential centrifugation was used to obtain the microsomes and cytosol. A significant increase in the cytochrome P-450 was the result of bubbling carbon monoxide, while a significant decrease was the result of UDP-glucuronyl transferase activity which was measured by adding microsomes and glucuronic acid. However, there was not a change between the rats treated with caffeine and coffee extract in the aminopyrine N-demethylase activity which was assayed by adding microsomes, aminopyrine, and Nash reagent, and in the activity of the glutathione transferase which was measured by adding cytosol and 1-chloro-2,4-dinitrobenzene. By using a spectrophotometer, the assays were measured. A change in the detoxification function in the liver of a coffee drinker which could be changed with the increase of cytochrome P-450 and the decrease of UDP-glucuronyl transferase activity could affect the tumor formation of the body.

#Second Award - U.S. Air Force
Third Award - General Motors ISEF/Biochemistry

OLFACTORY PERCEPTION AND MEMORY

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The purpose of this project was to determine the connections between olfactory perception and memory in different age groups. Participants were randomly selected in elementary grades through senior citizens. These participants were asked to smell stimulants that were selected to represent the seven basic scents. Then, results as to what memory was evoked was recorded. At the elementary age level, students tested associated each smell with objects that were common in their environment such as gum, ice cream etc. Middle school students, again associated the smells with things that were common in their environment but their answers were extremely limited. High school students began to show expanded association and were able to able to associate the smells to things outside their immediate environment. Adult participants associated the smells to things outside their immediate environment also. Senior citizens showed a slight trend toward associating the smells to things of past experiences.

# DIFFERENT ANTIBODIES WERE USED TO STUDY SUPEROXIDE DISMUTASE

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Superoxide Dismustase (SOD) is a novel, small in molecular weight, and structurally defined enzyme that catalyzes the dismustation of superoxide. Antibodies against SOD were raised in rabbit and chicken using conventional procedures. These antibodies were compared with respect to their abilities to recognize common antigenic determinants in SOD. Differences in the way the two antibody preparations recognized SOD were demonstrated by using methods, such as Enzyme-Linked Immunosorbent Assay (ELISA), electrophoretic, and Western Blotting techniques. The ELISA indicated that two antibodies competed for similar antigenic determinant, although to a varying degree. For example, a competition existed between two populations of antibodies when tested together against the antigen. Therefore, to define further the nature of these interactions, the SOD was treated with trypsin, a digestive enzyme that cleaves it into constituent polypeptides. These polypeptides were separated by a polyacrylamide gel electrophoresis. The peptides were then detected using Western Blotting procedures. The data generated by the Western blots suggested that the two antibody preparations may share some common antigenic determinant(s), since peptides with the same molecular weights were detected by both species. However, the results also revealed that the chicken antibodies detected some peptides that were different from the peptides detected by the rabbit antibodies.

#First Award - American Medical Associaton
Fourth Award - General Motors ISEF/Biochemistry

BIOLUMINESCENCE: A STUDY OF ITS CAUSES AND APPLICATIONS

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Bioluminescence, the ability of living organisms to give off light, was first introduced to me through a magazine article. This idea eventually became the foundation of my science project.

My project is based on four experiments. These experiments investigate the emission of light in fireflies, Cypridina hilgendorfii (Japanese sea fireflies), Armillariella melles (a type of fungus), and Vibrio fischeri (a type of bacteria).

I also explored several applications of bioluminescence. Aside from the more common applications, such as mating signals, I also studied unusual applications that ranged from Sigma's "magic" wand of heatless light to NASA's use of bioluminescence in hope of finding biological activity in outer space.

Bioluminescence has fascinated many people for thousands of years. However, many unsolved mysteries still remain, such as the evolution of bioluminescence. My final area of study takes a look at recent developments, especially tests that have been recently performed at the University of California at San Diego. The research that is being done today will contribute to the promising future of bioluminescence and soon, its mysteries will be solved.

LIFE WITHOUT GLUCOSE: ATP SYNTHESIS

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Glucose is very important for the growth and survival of cells. It plays a significant role in energy (ATP) metabolism. It is also the precursor of the sugar, ribose, which is essential for the synthesis of important compounds including ATP. Without glucose, ribose cannot be synthesized, and without ribose, ATP cannot be synthesized *de novo*. In this experiment I examined whether ribose is truly important for ATP synthesis and whether cells can synthesize ATP in the absence of glucose if supplemented by a ribonucleoside like uridine. Last year I proved that cells could synthesize DNA and grow in the absence of glucose if supplemented with uridine.

This project consists of two parts. First, the ATP concentration was measured in cells kept in three different types of culture medium. These were: DMEM (Dulbecco's Modification of Eagle's Medium) with 10 mM glucose, without glucose, or with 10 mM uridine. In the second part, the glucose, or uridine, in the medium was radioactively labeled with isotopic carbon (^{14}C). The ATP was then isolated by thin layer chromatography and tested for the presence of radioactivity.

The results of the first part showed that cells exposed to medium with glucose or uridine maintained their normal levels of ATP. Cells treated with glucose free medium had markedly lower levels of ATP. The results of the second part of the experiment showed that radioactivity from uridine does enter ATP, consistent with the supposition that ribose carbons, even provided from the outside, are a source for ATP synthesis.

STUDY ABOUT THE PRESENCE OF TRICHURIS MURIS IN PUERTO RICAN RATS AND IT'S IMMUNOLOGIC REACTIONS TO THE TOXINS OF THIS PARASITE.

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The main purpose of this investigation is to diagnose the presence of Trichuris muris in common rats in Puerto Rico, since previous investigations did not report this parasite. Also to study how the immunologic system reacts to the toxins segregated by the parasite.

The techniques and procedures used were: excrements test to diagnose the presence of Trichuris muris, differential test and C.B.C.

The results of the excrements test showed that V2, V3, V6, V8, and V9 were positive to the presence of Trichuris muris.

Two weeks later, the excrements test were repeated to the rats that were positive to Trichuris muris in the first test; the results revealed that the natural immunologic system has eliminate the parasite.

The immunologic system seems to be responding to the parasite's toxins because the C.B.C. revealed a significant difference between the quantity of the white blood cells in infected and non-infected rats. Also the differential counting showed lymphocytic and neutrophilic changes in the infected rats. A mod marked policromatophilia was found too.

After the analysis of the results, I concluded that many of the common rats in Puerto Rico, especially in the south area are infected with Trichuris muris, and the immunologic system seems to be responding against the toxins of the parasite.

A study of immunoglobulin, an immunoelectrophoretic analysis and histologic test of the infected rat's intestines are in process.

α-CHYMOTRYPSIN-CATALYZED ESTERIFICATION REACTIONS IN ALCOHOLS

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α-Chymotrypsin was used to catalyze reactions of N-Acetyl-L-Tryptophan with various alcohol solvents/reactants--methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, t-butanol, and benzyl alcohol. High Performance Liquid Chromotography was used to quantitatively measure these reactions. Isolated products were analyzed with Nuclear Magnetic Resonance and an ultraviolet spectrophotometer. Circular dichroism spectra from a spectropolarimeter were used to determine the enantiomeric purity of the ester obtained from the reaction of N-Acetyl-DL-Tryptophan in 1-propanol.

A CHEMICAL ANALYSIS OF TEARS INDUCED BY SELECTED STIMULI

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Human tears can be produced in response to emotional or physical stimuli. The purpose of this project was to discover why humans and not other life forms cry in response to emotions by seeing if a chemical difference exists in tears induced by a physical stimulus, onion vapors, and tears caused by emotions. It was hypothesized that a chemical distinction does exist between tears caused by different stimuli.

In the first year's experimentation, a crystal comparison and a simple protein test were run. However, further testing was needed to test the hypothesis. In the second year, a total protein test, a glucose test, and a sodium test were run on a Cobas Mira, a random access analyzer. Crystal comparisons were also run but more in depth than the first year. Results show that emotional tears contain more protein than onion tears and that onion tears contain more sodium than emotional tears; therefore the hypothesis was confirmed.

#THE LOCATION OF HMFGM GLYCOPROTEIN IN HBEC BY IMMUNOELECTRONMICROSCOPY

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The quantitative and qualitative variations between a normal breast epithilial cell line (HBEC), and a neoplastic cell line (MCF-7), were characterized through the comparison of the location of a monoclonal antibody against a specific milkfat globule membrane glycoprotein (HMFGM). Cell surface antigens in breast cells used as markers allow better definition in localizing tumor cells. Detailed examination under the electron microscope of the breast tissue treated with monoclonal antibodies revealed unique cellular and tissue formations only detectable with this approach. The differences in the location of the antisera were consistent. I found significant differences in the membrane labeling. The specific outstanding areas of variations were the microvilli, the polar bodies, and the intracellular lumena. The microvilli were elongated, abundant, and heavily labeled in the MCF-7. In the normal cell they were densely packed, sparsely labeled, and not significantly developed. The polar bodies are a membrane structure that correlates with microvilli. They are the area of the largest membrane gold accumulation and were found to be unique to the carcinoma cells. The intracellular lumena were also found to be unique to the carcinoma cells. In the MCF-7 the lumena were abundant and heavily labeled. Although the membrane labeling was present in both types of cells, the variations between the two were apparent. Therefore, the use of the outlined immunoelectronmicroscopy techniques allow for immense possibilities in the study of breast carcinomas.

#Second Award - General Motors ISEF/Biochemistry

INTRODUCTION OF METHYLTETRAHYDROFOLATE INTO CELLULAR METABOLISM: REMOVAL OF THE METHYL GROUP

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I have been studying methionine synthetase, an enzyme which transfers a methyl group from methyltetrahydrofolate ($CH_3\text{-}H_4PteGlu_n$) to homocysteine. This enzyme can use methyltetrahydrofolate substrates with 1 to 7 glutamyl residues. Most of the substrate molecules inside the cell have 5 to 7 of these residues, but methyltetrahydrofolate from the blood has only one glutamyl residue. I first compared plots of velocity of the enzyme-catalyzed reaction with methyltetrahydrofolate substrates containing one ($CH_3\text{–}H_4PteGlu_1$) or six ($CH_3\text{–}H_4PteGlu_6$) glutamyl residues. $CH_3\text{–}H_4PteGlu_6$ was a much better substrate at low concentrations. When the enzyme reacts with a mixture of the two substrates it preferentially uses the $CH_3\text{–}H_4PteGlu_6$. In fact, further experiments showed that the $CH_3\text{–}H_4PteGlu_1$ is not used until the concentration of $CH_3\text{–}H_4PteGlu_6$ drops below 2 µM. I concluded that methyltetrahydrofolate from the blood can only be used as a substrate when the cellular levels of methyltetrahydrofolate are low. Conversion of $CH_3\text{–}H_4PteGlu_1$ into $CH_3\text{–}H_4PteGlu_6$ requires three steps: 1) removal of the methyl group, 2) addition of 5 glutamyl residues by another cellular enzyme, and 3) readdition of the methyl group. By following these steps "new" methyltetrahydrofolate from the blood becomes a competitive substrate. My studies suggest that step 1 in this sequence, the reaction catalyzed by methionine synthetase, will proceed best when cellular levels of adenosylmethionine are high. This compound activates step 1 and inhibits step 3, keeping the concentration of long chain methyltetrahydrofolate (e.g.$CH_3\text{–}H_4PteGlu_6$) low as required by my studies. I propose that adenosylmethionine acts as a regulator for the introduction of methyltetrahydrofolate into cellular metabolism.

#First Award - General Motors ISEF/Biochemistry

THE EFFECT OF ELEMENTAL CALCIUM AND PHOSPHORUS ON RETENTION RATES OF ASCORBIC ACID (VITAMIN C) IN CYTOLOGIC METABOLISM

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Investigative studies were conducted on the effect of elemental Ca and P on the retention rate of ascorbic acid (vitamin C) in cytologic metabolism. Elemental Ca and P were utilized in groups of Ca to P and P to Ca ratios of varying units. Exact formulation was computed utilizing atomic weight, gram molecular weight, formula weight, and percent. composition. Experimentation of each group of ratios was performed three times with a standard ascorbic acid (vitamin C) titration solution. The maximization or minimization that Ca and P have on the retention rate of ascorbic acid (vitamin C) was calculated by the direct titration ratios with a standard ascorbic acid (vitamin C) solution. Control solutions for both Ca and P compounds were based on 1:0 and 0:1. Data collected and observed indicated that Ca has less of an effect on the destruction rate of ascorbic acid (vitamin C) in a system than does P. The retention rate of ascorbic acid (vitamin C) in higher Ca to P ratios fluctuated from slight to moderate, whereas, the retention rate of ascorbic acid (vitamin C) in higher P to Ca ratios declined dramatically. Experimentation indicatea a positive correlation between the ability of ascorbic acid (vitamin C) to be retained in metabolic processes to amounts of different ratios of Ca and P. This research is somewhat inconclusive in that verification of results should be formulated after actual experimentation within living cells is performed and compared to simulated conditions.

#ISOLATION AND CHARACTERIZATION OF THE DIHYDROFOLATE REDUCTASE mRNA FROM *SACCHAROMYCES CEREVISIAE*

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The purpose of my research was to isolate and characterize the messenger RNA for the dihydrofolate reductase enzyme in Baker's yeast, *Saccharomyces cerevisiae*. The research entailed five basic procedures: isolation of total ribonucleic acids from yeast, determination of optimal conditions for fluorescence of RNA sample sizes characteristic of electrophoresis, determination of electrophoretic conditions for maximum separation between the 18S and 25S ribosomal RNA species, optimization of the poly(A) RNA (mRNA) separation by agarose gel electrophoresis under denaturing conditions, and elution of the nucleic acids from the agarose gel subsequent to electrophoresis. Successful completion of four of these steps has enabled me to determine an empirical relationship between the mobility of RNA in gel and its corresponding molecular size. Once the remaining step of the research, namely optimizing poly(A) RNA resolution, is completed, a definitive conclusion as to the molecular size of the dihydrofolate reductase mRNA will be possible. I have found that for electrophoretic separation of RNA under denaturing conditions, electrophoretic parameters other than those suggested by Bailey and Davidson (the standard method for this type of denaturing gel electrophoresis), were more effective. In the course of this work, I have also designed an electrophoretic device which is more efficient in that it can allow simultaneous electrophoresis of several samples under different gel conditions within a single apparatus.

#First Award - American Society for Microbiology
Second Award - General Motors ISEF/Biochemistry

Detection of Rat Liver Protein Production in Xenopus Oocytes.

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Cells produce proteins in response to the transcription and translation of their own genes. Theoretically, cells will produce any produce any protein they can transcribe RNA for, even if the protein can not be used. This experiment investigates the possibility of detecting the induced production of Rat Serum Albumin and PepCK in Xenopus Oocytes by antibody testing(Molecular weight markers were used previously).

Oocytes were injected with Rat Liver RNA, incubated, homogenized to extract proteins, electrophorised, blotted and antibody tests were administrated(Standard procedures were altered to increase efficency of the antibody tests making bands clearer with less cross reactions).

Antibody tests for PepCK on injected and uninjected oocytes produced no definite bands. Albumin Antibody testing produced light bands in the molecular weight range of Albumin for the one and two day oocytes. Day three produced a dark band for Albumin while all controls were negative.

The data suggests that the oocytes did produce rat liver Albumin. While they did not produce PepCk or did not produce enough PepCK to be detected with antibody testing.

All derivatives deal with the detection of PepCK. Which are:
1 Inject only poly A RNA.
2 Clone the PepCK gene and injected only it's RNA
3 Use higher concentrations of protein in testing.
4 Incubate for longer periods of time.

A THREE YEAR STUDY OF CALCIUM UPTAKE IN THREE MUSCLE GROUPS OF SPECIFIC VERTEBRATE ANIMALS

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The purpose of Phase I was to determine the effect of calcium lactate on blood pressure, serum calcium, serum albumin, total serum calcium, and plasma pH. The Phase II purpose was to determine the differences of calcium uptake in various muscle groups. Phase III research was designed to compare muscle uptake of calcium and sodium.

Rabbits injected with various levels of calcium lactate were used in Phase I. Blood pressure readings were compared to each subject's baseline. Blood samples were assayed to determine the values of total serum calcium, serum albumin, plasma pH. Data was analyzed using the F test and Spearman Rho's rank order. In Phase II, the back, gut, and heart muscle was dissected from adult rats and was submerged in varying levels (6mM/l and 12mM/l) of calcium for 0.5, 3, or 6 hours. Phase III adds another mineral into the consideration of how it influences calcium uptake.

Phase I results indicate that while the intake of calcium produced significant increases in systolic and diastolic blood pressures, blood samples did not show significant changes in the total serum calcium concentrations or on serum albumin. Phase II data indicated that upon dissection there were significant differences between the different muscles. It was also found that the level of calcium concentration (6mM/l of calcium vs. 12mM/l) significantly affected calcium uptake in a positive fashion. Furthermore, time in solution significantly influenced calcium uptake in tissue at the 6mM/l of calcium concentration, but not at the 12mM/l of calcium. Phase III data, after t test results, showed that there was no significant difference between the tissue (back, gut, heart types and amount of time each tissue spent in varying levels of calcium or sodium concentration at the .01 level. However, there was a significant difference at the .05 level.

BIOCHEMICAL STUDY OF PTERIDINE CONTENT IN THE EYES OF DIFFERENT SPECIES OF DROSOPHILA FROM LATIN AMERICA: A COMPARATIVE STUDY

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Pteridines are organic compounds commonly found in the eyes of arthropods. *Drosophila melanogaster* is an arthropod usually used in genetic laboratories. The pteridines found in the eyes of *D. melanogaster* according to their classification are: Drosopterins (orange), Isoxanthopterin (violet-blue), xanthopterin (green-blue), Iepiapterin (yellow), 2-amino -4- hydroxypteridine (blue), Biopterin (blue) and Isosepiapterin (yellow).

In this work I attemped to determine the pteridines present in the eyes of different species of *Drosophila* from Latin America through paper chromatography using two solvents to compare what is best isolator using a mixture of ne-propanol: ammonia (2:1) and n-propanol: ethyl acetate: water (2:1:1) as the solvents. Its the first phase of this investigation. I took measurements of each part of the body of the different species of *Drosophila* from Latin America and also some mutations were observed to establish difference between them.

It was shown that the pigments that could not be identified in the others species of *Drosophila*, that were not *D. melanogaster*, was due to the fact that they did not exhibit the same sequence of pteridines shown by *D. melanogaster*. There was a variation in the body of each part of the body of the different species of *Drosophila*. The paper chromatography study that the best solvent is the show solvent n-propanol: ammonia (2:1).

BOTANY

THE EFFECTS OF CAFFEINE ON THE GROWTH OF GOLDEN WAX BEANS

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The purpose of this project was to determine what effects different levels of caffeine had on the growth of golden wax bean plants. If caffeine stunts the growth of bean plants and makes them weak, then plants which are being given high amounts of caffeine will be smaller and weaker than bean plants which are receiving smaller amounts of caffeine and the control plants which are receiving no caffeine.

Golden wax beans, planted in peat pots with potting soil, were watered every third day. The control group was watered with pure distilled water. The first, second and third groups of 18 plants were divided into divisions of 6. Each division was watered with a solution of distilled water with 200, 400 or 800 mg. caffeine. The first group was kept on the caffeine for the entire experiment, the second was gradually taken off and the third was taken off suddenly.

On December 23, 1986, the height of the plants, length and width of leaves, and number of leaves were measured. The dry weight of the plants was measured with a Mettler P162 Electronic Balance.

The division given the 800 mg solution for the entire experiment was adversely affected as evidenced by plant height and leaf structure. As the amounts of caffeine increased in the second group, the dry weight decreased. The third group had time for tissue repair after being taken off the caffeine which may account for the increase in dry weight as the caffeine increased.

THE EFFECTS OF AIR IONS ON LYCOPERSICON ESCULENTUM PLANTS

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The purpose of this project was to determine the effects of electrically charged particles, or air ions, on the development of plants. The first step was to construct an environment for the plants. A rectangular container with plexiglass front pieces was divided into four separate chambers. Wire mesh screens were suspended in three of the four chambers and wires were connected to a Van de Graaff generator. The first chamber, A, was the control and did not receive any charged particles. The second chamber, B, received negative ions, the third chamber C, received both negative and positive ions, and the fourth chamber, D, received positive ions. Burpee's Pixie Hybrid Lycopersicon esculentum (tomato) plants were used in all the chambers. The plants in chambers B, C, and D were ionized three times a day for six minutes each period of time. Group A, control, grew an average of 2.75 centimeters; Group B, electrons, grew an average of 1.05 centimeters; Group C, electrons and protons, grew an average of 1.0 centimeters as did Group D, protons. Even though Groups B, C, and D were close in comparison of heights, Group D was much weaker than all of the other plants. This experiment indicates that air ions can stunt the growth of plants.

THE USE OF ZINC AS A MILDEW DETERENT

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If mildew growth on roof tops could be reduced, the resulting longer life of the shingles would be economically and aesthetically beneficial. The observation of a roof top revealed that mildew was not growing in the region below a galvanized steel vent pipe. This led to the hypothesis that zinc leaching from the vent pipe might retard or eliminate the growth of mildew.

Sordaria fimicola was chosen as the mildew, whose growth was to be tested in a controlled environment. Sterile petri dishes, each filled with 10ml of Cornmeal-Yeast Agar, were divided into groups of five. The first group was the control group and had no treatment of zinc. The remaining groups were treated with amounts of powdered zinc ranging from 8g-12g. In the remaining group each dish was divided into two parts, one part receiving zinc, the other none, to determine the visual differences between the two. All groups were placed in a sterile environment and mildew growth was measured daily. The total mildew growth in squared millimeters was mapped daily using a grid system.

Results showed there was mildew growth in the untreated petri dishes; however, there was no mildew growth in the treated petri dishes. The growth in the untreated dishes ranged from 80-137 square millimeters in size. This result is now being applied in the making of a system which will leach zinc over an entire roof to keep it mildew free.

THE EFFECTS OF MAGNETISM ON GERMINATION

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The purpose of this study was to determine if seeds placed in a magnetic field would be effected as to the rate of and amount of growth. 150 radish seeds were germinated by wet towel method with and without magnetic influence. The number of seeds and amount of "sprout" was observed, measured, data recorded, and calculations interperted.

CLONING: ADULT TISSUE VS. SEEDLINGS - CARROT CALLUS OR CALLOUS CARROTS?

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Studying differences in callus formation *in vitro* of adult carrot tissue and carrot seedlings in a cloning process is this project's aim.

Surface sterilized carrot seeds were germinated on a medium. Leaves and roots of the resulting seedlings were excised and sections of the tender stem were placed on a callus induction medium. Sections of adult carrot tissue were obtained with a core borer and were placed on the induction medium. Aseptic technique was followed strictly.

The adult carrot section quickly became undifferentiated and grew well as callus tissue; however, problems with contamination resulted in only 10-20% success rate. The seedlings, having a smaller tissue mass, took a greater period of time in callus formation and had a higher success rate of 70-80%.

#Fourth Award - General Motors ISEF/Botany

ANTIBIOSIS OF SOIL BACTERIA ON PLANT PATHOGENS

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The purpose of this project is to determine whether or not soil possesses bacteria which inhibit fungi that cause plant diseases. The hypothesis of this project is to prove that bacteria in the soil will inhibit the germination and growth of pathogenic fungi.

Soil was obtained using a soil-sample method. After using the plate-dilution method, pure cultures were obtained. Inhibition was tested In Vitro and then In Vivo.

Zones of inhibition were observed on some of the test plates. Inhibiting bacteria were then tested in the plant-soil environment. In some individual experiments no fungi developed. In others, fungi killed the test host.

The data supports the hypothesis that bacteria found in the soil possesses anti-biotic properties. These properties inhibit the germination and growth of the fungi.

STATISTICAL ANALYSIS OF A5474 AND JEFF SOYBEAN CULTIVARS

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One hundred sixty-nine 5.83 meter plots each of two different soybean cultivars (cultivated variety) were compared for yields in 1986 near Weiner, Arkansas. The two cultivars were A5474 and Jeff. Means, Ranges, Variances, Standard Deviations, and Coefficients of Variation were calculated and compared for each cultivar. Jeff was the highest yielding and the most variable cultivar. These measurements were used to predict its yield stability in different environments and this study indicated that Jeff is probably less stable than A5474. Since yields are normally distributed, a prediction of yield performance was made. These calculations show the high and low expected yield for 68%, 95%, and 99% of each population.

THE EFFECTS OF PUERARIA THUNBERGIANA ON ANIMAL EPIDERMAL TISSUE

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Pueraria thunbergiana, also known as Kudzu, is a major problem in the United States. It grows at an amazing rate of one foot-a-day. After further research, it was found that the Japanese have used Kudzu as a therapeutic herb for centuries. This led the researcher to do studies to verify this phenomenon experimentally. It is not unreasonable to suppose that a substance is present in the Kudzu which promotes rapid growth. If the Japanese are correct, this growth-factor would also be effective on animal tissue. If such a substance could be isolated, it would be invaluable in the medical world. It could be used to help burn victims or surgery patients recover more quickly. Other applications for such a growth-factor would undoubtedly be discovered in time. The researcher conducted his experiments by adding Kudzu extract to living tissue cultures. A culture approximating natural conditions was also set up. The growth rates of the two were then compared statistically. The growth of the Kudzu treated tissue was at a rate which was significantly greater than the untreated tissue.

#A LONG TERM STUDY OF THE EFFECTS OF *LANTANA CAMARA* L. ON THE COMPLETE, DEVELOPMENT OF FOUR DIFFERENT SPECIES OF SEEDS: EMPHASIS ON THE IDENTIFICATION OF THE ALLELOPHATIC CONSTITUENTS

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Lantana camara is a weed found in Puerto Rico, known for its ability to supress other weeds release of toxic metabolites by plants, allelopathy, is a used supression.

After aplying 5% leave extract if was found that it reduced the percent of germination, number of roots and length of primary root of the four species of seeds used: *Phaseolus vulgaris*, *Brassica oleracea*, *Lycopersicon esculentum* y *Lactuca sativa*.

The leave possess volatile substances that reduce the percent of germination of the seeds (terpenes).

The extracts of the leaves possess a greater amount of allelophatic substance that the ones from the stems or roots. This was conduced using 4 concentrations (the ones mentioned above) on *Phaseolus vulgaris* and *Lycopersicon esculentum*. At higher concentrations, greater inhibitory effects were observed. The extracts reduced the percent of germination, length of the plant, number of leaves and also caused damage in the leave, cutyledon and stem structures. These extracts has the capacity to reduce up to a third part of the production of pods in *Phaseolus vulgaris*, decreasing the length of the pods, weight and number of leaves and besides damaging the structure of the plants.

The descomposition test with the leaves of *Lantana camara* with periods of 2, 4, 6, and 8 weeks at a concentration of 10% revealed a great inhibition in a period of 4 weeks. The substance is not active at 2 weeks and it has disappeared at 8 weeks of discomposition.

The NMR and IR spectroscopy analysis applied to the active substance obtained by column and preparative chromatography revealed importants tools for the identification of it. Comparing the obtained spectra with the ones presented in previous articles showed that the terpenes, lantanili acid and lantanolic acid are the ones that give the allelopatic properties to the weed *Lantana camara*.

#Scholarship - The Ohio State University
Third Award - General Motors ISEF/Botany

#INFLUENCE OF FERTILIZER AND PESTICIDE ON PINE SEEDLING

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A study was established to determine the effectiveness of newly developed time-released fertilizer + Bayleton (Pesticide) tablets placed near roots of slash pine seedlings on a site having poor quality near Perry, Florida. Bayleton was used to determine its potential in the reduction of *Cronartium quercuum* f. sp. *fusiforme* (fusiform rust) incidence and in the effectiveness on the symbiotic soil of ectomycorrhizal fungi. The fertilizer was added to show the nutrient's potential to increase seedling's survival and growth. At the study site, five treatments were used, including: (1) control, (2) fertilizer, (3) fertilizer + Bayleton (50 ppm), (4) fertilizer + Bayleton (100 ppm), and (5) fertilizer + Bayleton (150 ppm).

The results indicated that there may be a significant difference in seedling growth between treatments. No difference, however, appears in rust incidence and in the ectomycorrhizal population's treatment. Moreover, treatment (4) fertilizer + Bayleton (50 ppm) presents to be the best treatment among the five.

#Fourth Award - American Phytopathological Society

A STUDY OF THE COLD-HARDINESS OF GRASSES USED IN FLORIDA

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About nine years ago, in winter, 1978, a record cold-wave hit the Florida Panhandle; the temperature fell to 5° F., and an inch of snow accumulated on the ground. Five years later, on Christmas Eve, 1983, the temperature hit 0° F., although no snow fell.

These record cold-waves spelled trouble for the lawns of many homeowners. They all began to wonder, "What grass will survive this weather?"

Pursley Turf, in Palmetto, Florida, says that their Raleigh and patented Seville grasses are the most cold-hardy. Of course, no matter where you go, everyone is going to claim that their grass is the most cold-hardy; there's really only one way to answer the question- do an experiment yourself!

For the purposes of this experiment, I chose to use the following eight grasses, because they are the most frequently used in the Florida Panhandle: Raleigh, Pursley's Seville, Centipede, Foratam, Bitter Blue (also called Foratine), Pursley's Gulf Star, 328 Bermuda, and Emerald Zoysia.

Based on the results of the experiment, through week 20, it can be concluded that Raleigh, Emerald Zoysia, 328 Bermuda, and Centipede are the most cold-hardy grasses of those commonly utilized in the Florida Panhandle.

A second conclusion that can be made, based on the results of the growth pilot and experiment, is that cold-hardiness depends greatly on the growth rate of the grass.

#TRICONTANOL: HORMONAL-LIKE ACTIVITY OF SEVERAL CONCENTRATIONS ON GERMINATION, DEVELOPMENT AND GROWTH OF DIFFERENT SPECIES OF PLANTS

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Triacontanol is a 30-carbon primary alcohol. It was identified as a crystaline substance by Ries in 1977. This study represents an attempt to study the effect of this alcohol on the germination, development and growth of different species of plants.

First triacontanol was used at a low concentration (1.1876 X 10^{-8}M) against seeds of tomato (Lycopersicon esculentum), bean (Phaseolus vulgaris), corn (Zea mays), sorghum (Sorghum vulgare) and pigean pea (Cajanus cajan) for a period of 5 days. At this concentration triacontanol acted positively in the germination and growth of the five species of seeds used. The length of the primary root was measured and the higher affect was observed on Zea mays. The secondary and terciary roots were counted and Sorghum vulgare revealed the worst effects.

Also a 10 days period of study was conducted and the hypocotile development and the number of roots (secondary and terciary) were determined. The development of the experimental species was better than the control ones.

Six concentrations were made and applied to the same five species of seeds, the same parameters were taken into account.

Using S. vulgare, a production test were made in which the production period was increased by a factor of 3. The product was weighed and the experimental was 8% greater than the control.

A vegetative development test was done and the number of roots per stem were counted. The results revealed that more roots grew in the stems treated with triancontanol than in the control ones.

#First Award - Eastman Kodak Company

A STUDY OF THE POSSIBLE USE OF THE TROPICAL PLANT *MELIA AZEDARACH* L. FOR THE EXTERMINATION OF HARMFUL INSECTS

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The tropical plant *Melia azedarach* L. known for its narcotic, poisonous and insecticidal properties was used in the eradication of a series of insects harmful to agriculture and to man.

The investigation was done in eight different phases. On the first and second phase, larvas of *Aedes aegypti*, were treated with different concentrations of extracts from leaves and friuts; fruit extracts were the most effective part of the plant.

Water and Methanol were used as solvents to prepared extracts from leaves, fruits and stem in the eradication of seven species of harmful insects. 50% concentration was used. Extracts were tested in the fallowing insects: *S. batatos*, *S. germinata*, *N. costalis*, *P. americana*, *U. crassicornis*, *T. confusum* and *P. marginata*. Leaves methanol extracts were more effective in the eradication of *T. confusum* and water extracts in *N. costalis*. The insects died in a short lapse of time. The same seven species of insects were tested with 75% methanol leaves and fruit extracts. All insects died in a short period of time.

Thin layer chromatography showed leaf extracts to separate into six spots. Biological action was found restricted to spot 5 and 6 which may be the same. Separation of fruit extracts using the same method showed two spots. Biological action was restricted to spot 1.

Toxicity test was done with the larva of *Aedes aegypti* which died at 1% concentration with 75% fruit methanol extract and with the fresh water shrimp, *Attya scabra* which died at 3%.

Nasutitermes costalis, *Wild type* and *Menopan gallinae* were used in the repelence test. Positive results were obtained with the three species of insects.

Antifeedant test done with *Empyreuma pugiove* larva, that feeds on the leaves of *Nerium oleander*. The leaves were sprayed with *Melia azedarach* L. fruit extract and the larvae prefered to die instead of eating the sprayed leaves.

#Second Award - Entomological Society of America
Third Award - General Motors ISEF/Botany

TERATOLOGICAL, TOXICOLOGICAL, AND MUTAGENIC EFFECTS OF CHITIN SYNTHASE INHIBITING INSECTICIDES ON POLLEN

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The purpose of this research was to determine if chitin synthase inhibiting insecticides have fewer teratological, toxicological, and mutagenic effects on pollen, as compared to other agri-chemicals. Chitin is a polysaccharide component of the cell walls of filamentous fungi and the exoskeleton of arthropods. An enzyme, chitin synthase is involved in chitin production in these organisms. Recently, several substances have been found to inhibit chitin synthase enyzme forming the basis for a new group of insecticidal/fungicidal agents. Since pollen lacks chitin, it was hypothesized that the chitin synthase inhibitors would not have significant teratological, toxicological, and mutagenic effects. The chitin synthase inhibitors were tested for teratological and toxicological effects at 10^{-4}M, 10^{-6}M and 10^{-8}M; and for mutagenic effects at 10^{-8}M. Several representative insecticidal/fungicidal agents were tested for toxicological and teratological effects at their recommended rates and at 10^{-4}M; and Sevin and Funginex were tested for mutagenic effects at their recommended rates. Results were recorded in percent of controls. Polyoxin-D and Dimilin were found to have fewer teratological, toxicological, and mutagenic effects on pollen, as compared to other agri-chemicals. Research indicates that Polyoxin-D and Dimilin may possibly be useful as insecticidal/fungicidal agents during bloom season.

#VARIABLES AFFECTING SEED IMBIBITION RHYTHMS

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In earlier phases of this study 630 groups of seeds were allowed to imbibe water for 3 hours under conditions of light or dark, morning or night. Values of t tests showed that most seed varieties had significantly greater night or morning gains, and that light was often a variable. Seed size of a variety was found to be unrelated to imbibition. An attempt was made to see whether there was a relationship between apparent rhythms and selected hormones. 590 groups of seeds were weighed, allowed to imbibe water, hormone solution, or inhibitor, dried and reweighed after 3 hours. Seed soak-water was tested for phenols and protein. 104 groups of monocot seeds were imbibed under red or far-red filters for photoreversibility to indicate phytochromes. Only one type of seed responded positively to added gibberellin, and one gained less with GA inhibitor. Most seeds in phytochrome inhibitor followed control patterns. Photoreversibility was found in less than 17% of the monocots. Tests for phenols were negative, tests for proteins positive.

Research done this year included: testing 144 seed groups in extracts of short-day plant leaves, at a time when the leaves should have contained high levels of active phytochrome, and comparing them to long-day leaf extract groups and water controls; testing dicots under red and far-red filters; and adding calcium chloride to soak-water to try to enhance phytochrome actions. While a few kinds of seeds did respond to the tests in a manner to suggest phytochrome influence, circadian rhythms in seeds seem to prevail despite chemical inhibitors or stimulants.

#First Award - American Society of Agronomy

EFFECTS OF SUCROSE, PROLINE, AND SALT ON THE GROWTH OF CULTURED SALTGRASS CELLS

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The purpose of this research was to observe the growth of saltgrass (*Distichlis spicata*) cell cultures when subjected to stresses induced by NaCl and sucrose, and to determine whether the addition of proline to the medium effects cell growth. It was hypothesized that increased NaCl and reduced sucrose concentrations should inhibit cell growth, and that proline should stimulate growth.

Saltgrass cell cultures were grown in 0 and 260 mM NaCl with 1%, 2%, and 4% sucrose, and in 0 and 260 mM NaCl with 2% sucrose and 0, 2, 10, 20, and 58.8 mM proline. Random dry weights were taken to determine the mass of the cell structure as a percent of its total fresh weight. Chemical assays were performed to determine the actual concentration of proline both in the media and within the cellular structure.

The results revealed that cells in the 0 mM NaCl, 4% and 2% sucrose groups grew more rapidly than their 260 mM NaCl counterparts and much more rapidly than both 1% sucrose groups. Proline of any concentration was inhibitory to growth in the 0 mM NaCl-treated cells. However, 2 mM proline stimulated growth in 260 mM NaCl-treated cells, and the average relative growth of these cells exceeded that of the control (0 mM proline, 260 mM NaCl).

#STIMULATORY ACTIVITY OF GIBBERELLINS FROM EICHHORNIA CRASSIPES (M.)S.) AND PHOTOPERIODISM ON GROWTH RESPONSES OF SELECTED CROP PLANTS

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The study dealt with the extraction of gibberellins from water hyacinth (*Eichhornia crassipes*)roots using water as solvent. Two kinds of extract were made: crude aqueous extract and clarified aqueous extract. The two extracts were tested on their stimulatory effect to germination and shoot initiation of seeds of mustard (a long day plant), rice (a short day plant) and corn (a day-neutral plant). Three factors namely varying concentrations of gibberellins (in the ratio of gibberellins is to water expressed as percentage by volume of 0%, 2%, 3%, 5%, and 7%), kinds of extract (crude and clarified aqueous) and photoperiodism (normal and reverse) were considered. The clarified aqueous extract in 2% (0.25ml/15ml) and 3% (0.5ml/15ml)concentrations best stimulated seed germination and shoot initiation.

Likewise germination and shoot initiation of seeds of long day plant and short day plant exposed to reverse photoperiod were slightly inhibited under the condition. But with the addition of exogenous gibberellins, the seeds were stimulated to germinate and initiate longer shoots than the control (i.e. without gibberellins at normal photoperiod).

Statistical analysis showed that there is a significant difference in the number of germinated seeds in the control and experimental setups. The number of seeds germinated and the length of shoots were affected by concentration and kind of extract.

An interactive effect exists between gibberellins and photoperiodism on the growth response of rice and mustard seeds. There was no interaction seen in seed germination and shoot elongation of corn since it was a day neutral plant.

#First Award - American Statistical Association

#THE MODULATION BY CALCIUM OF THE EFFECT OF CAFFEINE

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Caffeine is one of a number of compounds that have been shown to inhibit plant cytokinesis producing binucleate cells. In the presence of caffeine, the Golgi vesicles do not accumlate and fuse to form a new cell plate. Caffeine probably interferes with intracellular calcium.

Studies of calcium deficient cells undergoing cytokinesis have shown that Golgi vesicles failed to fuse into a new cell plate. If calcium is replaced to normal levels, normal cell cycles resume. Thus it is believed the inhibition by caffeine can be modulated by the addition of calcium.

The tips of the roots of the onion, *Allium sp.*, were used in this study. Roots were placed in caffeine or caffeine-calcium solutions for four hours. Counts of binucleate cells were done after fixation and staining.

The results of this study indicate that calcium modulates the inhibitory effects of caffeine in cytokinesis of onion root tip cells. This modulation increases with the increasing concentrations of calcium used in this study.

#First Award - National Association of Biology Teachers

*APPLICATION OF MONOCLONAL ANTIBODIES IN THE DETECTION OF OAK WILT

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Oak wilt, the most destructive oak disease in North America, threatens thousands of acres of live oaks in Texas. There is no cure for oak wilt, nor an effective means for checking its spread.

Currently, the presence of the _Ceratocystis fagacearum_ fungus, the causal agent of oak wilt, is confirmed in the laboratory by a procedure that takes approximately ten days. The objective of my research was to develop a simple, on-site diagnostic test for the presence of _C. fagacearum_. This test will save arborists and researchers much valuable time in the detection of oak wilt.

First, it was necessary to develop a highly specific and pure monoclonal antibody against the fungus, _C. fagacearum_. To do so, mice were immunized with an antigen prepared from the spores and hyphae of this fungus. Next, the antibody producing mouse spleen cells were fused with mouse myeloma cells. After the fused cells propagated, ELISA was performed to detect antibody secreting clones. These clones were tested for specificity, mass produced and preserved both by freezing and lyophilizing.

Second, a diagnostic precipitation test based on the antigen-antibody reaction was tested and cross-tested. Branch samples from healthy live oaks and those showing active symptoms of oak wilt were collected, sectioned and soaked in a saline solution. The resultant solutions were filtered and added to test tubes containing a sucrose-monoclonal antibody solution. The formation of a white precipitate, the fused antibody and antigen, confirmed the presence of _C. fagacearum_ in all symptomatic trees tested. No reactions occurred in the controls.

*First Award - American Phytopathological Society
First Award - Eastman Kodak Company
First Award - U.S. Air Force
First Award - U.S. Army
London International Youth Science Fortnight Trip - U.S. Marine Corps
Second Award - General Motors ISEF/Botany
Alternate to Scholarship - American Committee for the Weizmann Institute of Science

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COMPARATIVE HERBICIDAL APPLICATIONS ON KOCHIA SCOPARIA

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Purpose: The purpose of this project is to determine which contact herbicides applied at different stages of growth will eradicate _Kochia scoparia_. _Procedure_: Authorities were interviewed. _Kochia scoparia_ seeds were collected. Slides of seeds were made. Planters and watering trays were built. Germination rate was evaluated. Seeds were planted. Artificial lighting was installed. Volume per spray of chemical was calculated. Herbicides were diluted and prepared into solutions. Plants were sprayed in two categories of growth: Phase 1 and Phase 2. _Observations_: _Kochia scoparia_ plants were observed for two weeks after the initial spraying of chemical. _Results_: Buctril proved to be the most effective in Phase 1 followed by 2,4-D amine. 2,4-D amine was the most effective in Phase 2. _Conclusion_: Because all the chemicals proved to be somewhat effective in Phase 1 growth, plants should be treated with chemical as soon as possible while they are still in their early growth stages. As the plant matures, it will become more difficult to eradicate. _Application_: By applying the right chemical at the correct stage of growth, not only can the troublesome _Kochia scoparia_ be eliminated, but water and nutrients such as K, N, P, Ca, Fe, Mg, and Zn can be conserved for crop plant utilization.

# NEW REVELATIONS AIR-A-PONICS VERSES THE FAST GROWERS SYSTEM

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PURPOSE: To determine if the Brassica rapid cycle crucifer can be grown in the Air-a-ponics system and to compare this growth with the Brassica rapid cycle crucifers grown in the Fast Growers System.
HYPOTHESIS: This researcher predicts that if the plants in the Air-a-ponics system germinate, their growth and development will be inferior while the plants in the Fast Growers System will develop to their fullest extent.
PROCEDURE: Additional lights were placed three inches above the plants in both systems. Three seeds were placed inside each nipple on paper fiber in the Air-a-ponics system, and in the Fast Growers system three seeds were placed in each mini-pot and covered with soil. Both systems were given equal light and nourishment and allowed to grow.
RESULTS: Most seeds germinated within twenty-four hours and continued to grow approximately a centimeter a day. At the end of the twenty-one days there were no distinct differences between the plants grown in the two systems.
CONCLUSION: The Air-a-ponics system was successful in germinating and growing the Brassica campestris, this growth was comparable to those grown in the Fast Growers system. However, there were many distinct advantages in using the Air-a-ponics system such as being able to view the entire germination process and having a controlled enviornment, free of mold, which makes it a superior system in many ways.
APPLICATIONS: The Air-a-ponics system can be used by researchers as well as teachers to study and view the complete growth and development of the entire plant. This system can be useful to plant breeders, home gardeners, and researchers looking for an alternative and viable method of food production for the future on earth and in space.

#First Award - General Motors ISEF/Botany
First Award - National Aeronautics and Space Administration
First Award - Patent and Trademark Office/U.S. Department
of Commerce/Patent and Trademark Office Society

A PHYSIOLOGICAL STUDY OF ANAEROBICALLY GERMINATED RAPHANUS SATIVUS

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The purpose of this study is to determine the effects of an anaerobic environmental condition on the physiology and growth of the radish, Raphanus sativus.

Preliminary results demonstrate that Methylene Blue, an oxidizing agent, supports germination in the absence of molecular oxygen, however, growth of seeds that germinated was slower. Anaerobic germination is theoretically impossible. These experiments are designed to determine Methylene Blue's role in anaerobic germination. It is hypothesized that Methylene Blue is allowing some ATP synthesis by functioning as an electron acceptor in the respiration chain. Since Methylene Blue is not as strong an oxidizer as molecular oxygen, fewer ATP's are synthesized than in aerobic conditions. This may account for the observed decreased rate of growth in the experimental group.

Much of the data emerging from this series of experiments may have application towards the utilization of space as a feasible place for food production, in the future.

#Second Award - General Motors ISEF/Botany

EFFECTS OF AGROBACTERIUM TUMEFACIENS ON MONOCOT AND DICOT PLANTS

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My project involved the effect of the bacteria, *Agrobacterium tumefaciens*, on different plants.

I started my project thinking that this was a harmful bacteria and would be lethal to any plants I treated with it. I thought that if farmers had this bacteria in their fields, they would have to destroy their crops or would have to find a way to neutralize the factors causing the disease.

After referring to several publications and handouts, I developed ideas on how to apply the bacteria to the plants. The method I adopted was to puncture the stem with a needle or pin and then I spread the bacteria over the holes. I did this to three out of four dicot and monocot plants. On the first trial, there was no observable differences between the treated and untreated plants. After consulting a botanist, I was adviced to use seeds that were not treated with fungicide.

On my second trial, I used untreated seeds and replanted dicot and monocot plants. I also expanded the experiment using ten different kinds of plants, five in each category.

In conclusion, the results of the second trial demonstrated that when the bacteria was added to the dicot plants, there was a tumerous growth on the stems at the application site. On the monocot plants, no growth occurred. The effect of *Agrobacterium tumefaciens* on dicot plants proves to be a dangerous plant pathogen. There is no obvious effect on monocot plants.

#DISEASE ANALYSIS OF SUNFLOWERS WITH NUTRITIVE INTERACTIONS

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I am investigating the types and severity of diseases on sunflowers in West-Central North Dakota, how the plant's nutrition is affected by the diseases, and how mineral nutrition might be used to control the severity of the fungal effects.

Percent necrosis ratings were taken on the leaves in field plots containing 30, 50, 60, and 90 pounds of nitrogen per acre and a total of 11 cultivars. Samples were collected and plated and isolations of the fungi were made. Pathogenicity tests and hydroponic inoculations were then performed. Analysis of variance and chi-square tests were used to detect statistical differences.

The results indicate that the major pathogenic organisms invading the field were *Phoma*, sp., *Helminthosporium sativum*, a member of Ascomycetes, and 5 species of *Alternaria*. The lowest necrosis ratings were found with 60 lb./A. of nitrogen, and the highest with 90 lb. Symptoms of N, Fe, Mg, and P deficiencies and a potassium toxicity were noted even with a spore concentration of 25,000 spores per milliliter.

In conclusion, the translocation of nitrogen appears to be impaired when the sunflowers are under stress. Senescing of the leaves and high concentrations of N appear to increase the severity of the disease symptoms. Most of the *Alternaria* species seem to prefer infecting leaves with low photosynthetic efficiency and glucose levels. By increasing the rate of glucose utilization and activating the enzymes in the fungus into organic material, the severity of the disease appears to be diminished. By continuing my research and improving the fungal suppressant nutrient solution that I have developed, I hope to prove that the utilization of fungicides can be avoided in some cases.

#First Award - U.S. Navy
Third Award - General Motors ISEF/Botany

#COMPLEMENTATION OF *EXO* LOCI BY *PSS/PSI* AND HOMOLOGY WITH *R.MELILOTI*

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The initial phase of my study involved the mating of clones of *Rhizobium phaesoli* that were either polysaccharide inhibitors (*psi*) or polysaccharide synthesizers (*pss*). By tri-parentally mating transposon induced mutant clones of the *exo* loci with *psi/pss*, complementation can be determined. If complementation is achieved, the strain would be calcofluor bright and *nod+* *fix+*. If no complementation occurred, then the strain would be calcofluor dark and *nod+* *fix*$^-$. Under examination, using ultraviolet light, all strains appeared dark on the calcofluor media having a phenotype of *nod+* *fix*$^-$.

The second phase was concerned with the homology of the DNA present in clones of *psi/pss* with DNA of *R.meliloti*. The genomic DNA of *R.meliloti*, *R.leguminosarum*, *R.trifolii*, *E.coli*, and *A.tumefaciens* was isolated and cut with EcoRI after being purified by a cesium chloride gradient. It was transferred to a hybridization membrane by means of a Southern blot. The non-amplifiable plasmids were isolated and cut with EcoRI yielding the 3.5kb (*pss*) and the 2.4kb (*psi*) segments. The probes were labeled with ^{32}P and a nick translation was carried out. Homology was determined by hybridization and autoradiography. Homology was present between *R.meliloti*, *R.leguminosarum*, *R.trifolii*, and *A.tumefaciens* and the *pss* probe. The *psi*, however, was homologous with alfalfa DNA and not Rhizobia.

Currently, I am studying *pss* homology with a cured strain of *A.tumefaciens*, other *R.meliloti* strains, and *Frankia* DNA using a biotinylated probe (April 27, 1987). In order to achieve a better yield, the *pss* plasmid was subcloned into a pUC18 vector. Colony hybridization was used to check for plasmid presence.

#First Award - General Motors ISEF/Botany

A THREE YEAR STUDY OF SEED GERMINATION RATE PROBLEMS OF *CORONILLA VARIA*: PHASE III DRASTIC SEED TREATMENTS DESIGNED TO IMPROVE GERMINATION

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Crown vetch has gained wide acclaim as a conservation plant for slope stabilization and is a promising forage plant. Crown vetch has helped control a 15 billion dollar erosion problem. Even with its forage potential, low germination rates, seed scarcity, and the related high seed costs are causing a delay for this use. Phase I of this project was designed to determine whether physical factors are significantly important to germination rates.

Seeds were separated according to five colors: green, tan, medium brown, dark brown and burgundy. In Phase I, samples of each color were measured and weighed to determine size and density. In Phase II, results from Phase I research were used as the control. Test samples were treated with giberellic acid, sulfuric acid, microwaves, boiling water, and scarification. Six trials of each test sample were performed and all data was statistically analyzed using the t-Test results.

Phase I data showed that color was highly significant to the germination rate. All color tests were evaluated to have a significance level of 0.001. This is very highly significant in the low germination rate of *Coronilla varia*.

In Phase II of research, all tests improved germination by at least 50% and in one case, a total of 70%. The p value for boiling the seed was 0.001, which is very significant. The p values for microwaving, scarification, and hormone were also 0.001.

Phase III tests were run to see if more drastic seed treatments would improve germination. These were: radiation, allelopathy, freezing point gravitational force and animal digestion. All tests improved germination by 80% with a very significant p value of 0.001.

In making a global conclusion, one would notice from the data obtained that if the seeds were pre-treated or pre-sorted before marketing the consumer would get the best quality seed for a much more efficient price.

DETERMINING AND COMPARING THE EFFECTS OF HORMONES ON PLANT GROWTH

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The purpose of this project was to see how different strengths and combinations of hormones and different waters effect the growth of African violets, sweet potatoes, tomatoes and three types of beans. Ten different pills containing different amounts of estrogen and/or progesterone were dissolved in separate containers having 1000 cc. of well water or distilled water. Plain water was used for each Control group. These solutions were used to sprout and grow each type of plant. Records were kept for emergence and root and leaf development. African violets show faster growth with plain distilled water; sweet potatoes had greater growth with well water/progesterone solution; tomatoes did best with well water and small amounts of estrogen/progesterone; best results for Navy beans were with distilled water and mild estrogen/medium progesterone; String beans did best with distilled water and low amounts of estrogen/progesterone and Soybeans showed greater results with distilled water and small amounts of progesterone. Research is being continued.

DETECTION OF RESPIRATORY AND PHOTOSYNTHETIC ACTIVITIES

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A setup is constructed for the detection of respirotory and photosynthetic activities of various organisms. The organisms (which could be seeds, plants or animals) to be tested is put into one or both of the containers. The U-tube is filled with indicator solution. When respiration takes place, precipitate or color alternation will occur in the U-tube. If an animal is kept in one of the container only, it is afflicted with suffocation. However, when a plant is put in the other container shone with strong light, the animal will live actively, because photosynthesis of the plant will supply oxygen to the animal.

The apparatus is simple and inexpensive to make, but offers a quick and sensitive way to the detection of respiratory and photosynthetic activities for plants and animals.

SOURCE ACTIVITY IN THE CHLOROPHYLL CONTAINING TISSUE LAYERS OF DEVELOPING GRAPEFRUIT

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Isolated tissues from young grapefruit were utilized to determine the capability of individual fruit tissues to contribute photosynthate for fruit growth and development. The phytosynthate required for fruit growth originates predominantly in phytosynthesizing leaves, a source region, and is transported through the phloem to the fruit, a sink region. The major product of source activity is sucrose. However, some tissues of the developing grapefruit (a sink) also appear to be capable of acting as a source.

In this research the amount of $^{14}CO_2$ fixed by grapefruit leaf and fruit tissues and the amount of sucrose produced during this fixation were measured as an estimate of source activity. The outer chlorophyll-containing layer of the fruit peel (flavedo) fixed 3.7-fold more CO_2 in the light than any other fruit tissue. The major products of CO_2 fixation by both flavedo and leaf tissues were neutral sugars. In contrast, neutral sugars accounted for less than 50% of the fixation products in other fruit tissues examined. This data is consistant with the hypothesis that the flavedo can act as a source.

THE ISOLATION, CULTURE AND FUSION OF PROTOPLASTS FROM THE CARROT AND TOBACCO CELL SUSPENSIONS

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The interest in protoplast fusion techniques is related to the prospect that wider crosses than are now possible by sexual means may be achieved with protoplast fusion. For example, some plants that show physical or chemical incompatibility in normal sexual crosses may be produced by fusion of protoplasts obtained from two cultures of different species. Carrot and tobacco cells were isolated and protoplasts were obtained from rapidly growing carrot cell suspensions and from young tobacco leaves which were found to be the most suitable combinations. The walls of the plant cells were removed with cellulase enzyme which allowed cell membranes to come in contact with each other and opened the way to fusion between protoplasts. Equal volumes of carrot and tobacco protoplasts were mixed together, centrifuged for 5 minutes at 300 rpm and removed from the supernatant with a pasteur pipet. The protoplasts were resuspended in 1 ml of sugar solution. The protoplasts were placed on a concave slide and allowed to settle for 5 minutes. Then 3 drops of fusion reaction substance (PEG) was placed on the slide. PEG, which is Polyethylene Glycol, was used to induce protoplast fusion. Protoplasts were incubated in PEG solution at room temperature for 15 minutes. After 15 minutes, the protoplasts were observed fusing. The greatest potential for this technique was the opportunity of producing hybrids which could not occur as a result of sexual hybridization.

WHAT EFFECT DOES A FERTILITY DRUG HAVE ON PLANTS?

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Bush beans were planted and divided into five groups. One group was given faucet water. The other four groups were given a fertility drug, Clomid. A total of 375cc of liquid was given to each group twice a week. The amount of drug given varied with each group. The plants were measured regularly and the results noted. The beans were picked, counted and measured. All the information gathered was computed mathmatically to prove the end results. The fertility drug, Clomid, does have an effect on plants and their products. This was shown by the growth of the plants and their crop. A mathmatical analysis of the plants growth differences was made to prove that there was only a 0.001% chance that anything other than Clomid had effected the size of the plants. The same math computation was made on the number of beans and their size. The control group, "C", produced as many beans totally as any group. These beans varied in length from 9 to 11 cm. The other groups produced basically the same number of beans but their size was smaller. At maturity the plants given the drug averaged 29% larger than the ones in the control group. The crop yield among the groups was within 5% of one another. The beans in the control group averaged larger than the others. Therefore, I believe that it would not be feasible to give plants a fertility drug because of the cost involved and the fact that there would be no significant increase in the crop yield. I feel, had the beans been planted in deeper soil, that the crop yield would have been much greater. There were also indications that the groups given the drug may have produced more beans but probably of a smaller size.

DOES PRE-SOAKING SEEDS INFLUENCE GERMINATION RATE?

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The purpose of this experiment was to determine whether pre-soaking vegetable seeds, in distilled water, prior to planting, sped up their germination rate. This pre-soaking method was chosen as the best solution to break their dormancies, and later to allow a comparison between the germination rates of pre-soaked and unsoaked seeds.

Cauliflower, lettuce and celery seeds were pre-soaked at pre-determined intervals (48 hours, 24 hours, 12 hours and 3 hours) and planted in 5 greenhouse trays. Results were recorded periodically which measured the number of new sproutings.

The data suggested that the pre-soaked seeds did in fact sprout first, but the pre-soaking time was not a factor in the final results of the experiment. This method, if properly combined with other germination factors, such as temperature, storage, moisture, etc., may in fact speed up the germination process.

EXTRACTS OF COMOCLADIA GLABRA AS A POSSIBLE INSECTICIDE FOR THE ERADICATION OF BOOPHILUS MICROPLUS

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Boophilus microplus, commonly known as the tick of tropical cattle is a plague in which the government of the United States and Puerto Rico spend a considerable amount of money each year. At the present, the only way of controlling it is by using chemicals which contaminate the host and environment.

Extracts from different parts of the plant at a concentration of 75% were made. The purpose of this research is to develop an effective natural control of this tick using extracts of Comocladia glabra (Carrasco plant)

The results demonstrated that 60% of tick exposed to the substance obtained directly from the plant died. Also 100% of the eggs exposed to extracts from the stem of the plant died also.

As future projections it is planned to create an insecticide to control the tick in their egg phase and to find the constituents of the plant that prevent the development of tick eggs.

#Fourth Award - General Motors ISEF/Botany

A COMPARATIVE STUDY OF 102 WOODS FROM PUERTO RICO WITH ATTENTION TO THEIR CHEMICAL AND PHYSICAL PROPERTIES

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Urb. Villa Interamericana #4, San Germán, PR 00753

This study is an attempt to analize the physical and chemical properties of 102 trees from the forests of southwestern Puerto Rico.

Physical tests included: density, flotability in fresh and salt water, color, texture, shrinkage under not urels conditions, penetration and compression. The penetration test was done to determine the resistance of each wood for the penetration of a pointed object. The compression test consisted in submiting the woods to a compressing machine to found the highest pressure the wood resisted after breakage. A test to determine the ability of the wood to absorb water during a 12 hours period was performed.

Among the chemical tests the determination of percent of water mineral content and organic matter of each block of 3" X 3" x 1" were carried out. The heat of combustion in Kilocalories for each block of wood was also found. The time H took to burn completely to ashes and the time it took to ignite were determined.

The resistance of the different woods to termites were also done. A photographical analysis of the contex of each tree were performed.

#EFFECTS OF PHYTOCHROME RESPONSE AND EXOGENOUS ION CONCENTRATION ON THE TRANSMEMBRANE ELECTRICAL POTENTIAL OF PULVINAR CELLS

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The circadian cycle of nyctinastic plants is based upon the ionic induced turgor fluxes within the pulvinar cells. The pulvinus is an organ that allows leaf movement in plants. This organ can be divided into two sections, the extensor cells and the flexor cells. It has been suggested that the cell membrane plays a key role in the circadian turgor cycle. The purpose of this project was to define that relationship, and to attempt to alter it using ion concentration and light waves. In this project it was hypothesized that the electrical membrane potential was directly linked to the circadian turgor and leaf movement cycles.

Experiments were conducted on tendergreen bush bean plants. The pulvini were excised and perfused with either of two stock solutions. The electrical membrane potential was taken through standard microelectrode technique. The experiments were conducted on a variety of subjects. Test 1 indicated that the membrane potential and turgor change was related. Test 2 and 3 exhibited that the electrical membrane potential could be influenced through foreign ion concentration or spectrums of light.

From these results, I was able to deduce that the electrical membrane potential of pulvinar cells is critically linked to the ionic turgor changes and overall circadian rhythms of nyctinastic plants. This potential can be altered by outside stimulus in much the same way as ionic turgor fluxes are.

#Second Award - General Motors ISEF/Botany

POSSIBLE POSTPONEMENT IN THE PROCESS OF RIPENING IN MUSA ACUMINATA

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Banana is a fruit traditionally included in the daily puertorican diet. Due to the accelerated ripening process, farmers have great losses when marketing this product, thus depriving many families of including it in their meals.

Based on this observation, I did some research in trying to discover a method to prevent this rapid ripening process of the banana. According to my studies this process is due to the interchange of atmospheric gases and ethylene.

The variables used were. (1) banana in water; (2) in soil; (3) in a plastic bag inside a refrigerator; (4) alone (uncovered) inside a refrigerator; (5) inside a plastic bag outside in the shade; and (6) in distilled water. After five months of observation, the variable that was most effective in the postponement of the process of the banana ripening was the banana in water.

In conclusion, if the farmers preserve this fruit in tanks full of water, they could keep it fresh and green for approximately one month. After such a long time of conservation, the bananas can be sold as a fresh fruit, since its natural qualities and nourishing properties have not been altered.

#[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]
[illegible]
[illegible] n, C. [illegible] an, [illegible], [illegible] 44403
4005 [illegible] Ave., [illegible], [illegible] 44403

Thioethers are a sulfur based petroleum product. Russian scientists found that "spring wheat and rye yields were found to increase by twelve to twenty percent as a result of petroleum sulfone application."* Sulfones are an oxidation derivative of thioethers. First, the thioethers were distilled into three main fractions: 400 -450 F, 450 -4[illegible] F, and 4[illegible]-5[illegible] F. These were then reacted with [illegible] and [illegible] in an attempt to obtain sulfones. Then, the thioethers, the thioethers reacted with [illegible], and the three sulfones were applied to wheat and bean plants in concentrations of 1%, [illegible], .4%, and [illegible] before and after germination. [illegible] were [illegible] to corn, [illegible], [illegible], and [illegible] before germination. All three substances delay germination with the thioethers reacted with [illegible] delaying it the longest--up to 7 days in bean plants. This substance also helps bean plants develop more quickly than the control plants. All these substances cause wavy and broken wheat blades and thicker and tougher leaves in beans. Because these substances have different effects on different plants, they could also be used as herbicides. In [illegible] plants the emulsions will eventually kill the plants while in corn plants they seem to have no effect. In radish plants the thioethers seem to have no effect but sulfones kill the plants while it is the opposite in beans. Both the thioethers and the thioethers reacted with [illegible] reduce the evaporation rate from both the soil and from the plants themselves. This could be beneficial in low precipitation areas and could increase crop yield where limited water is available.

#Third Award - General Motors ISEF/Botany

*[illegible] Dermatology 339

Plant Systematics...
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The purpose of this project is to classify common Oklahoma flora into various taxons according to their natural relationships. This classification is based upon raw data derived from 46 morphological characteristics of the 98 plants used. This was done through the use of a numerical taxonomy computer program which provided a distance matrix, a three-dimensional projection, and a phenogram. This data was then taken and used in the writing of a dichotomous key in which the 98 plants were classified according to the numeric means. This key was then compared to a conventional classification scheme to determine if the numeric system is a better way to classify organisms.

By observing the three-dimensional projection, the phenogram, and the dichotomous key, I observed that classification schemes arrived at by numerical means show good agreement with those arrived at by traditional means. One can possibly conclude that experienced traditional taxonomists such as Dr. Doyle McCoy and Dr. U. T. Waterfall are just as efficient as the computers used in numerical studies. The beauty behind both systems is the fact that each of the two systems are compatable with each other.

ACCELERATING RATES OF COLD ACCLIMATION IN WASATCH CONIFERS

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Cross elevational samples of conifers, as well as samples from elevational transplants, were tested for water content, glucose levels and solute concentrations. External variables other than temperature were carefully controlled; isolating temperature and daylength as variables. All samplings were repeated periodically over a fifteen month period. As temperature lowered, glucose levels increased; other solute concentrations, and water levels within the needles, remained constant year round. Glucose levels then decreased as temperature rose, and daylength increased during the spring and summer. The transplanted conifers maintained concentrations equivalent to the conifers in the colder temperature range they were removed from- with no indications of gradual adaption. Engelmann Spruce seedlings were used to determine frost hardiness after manipulating daylengths and temperature. Frost hardiness was determined through the measurement of plant conductivity. The seedlings were able to acclimate and increase frost hardiness levels increased rates; both low temperature(2*C) and short day(8 h) treatments were used at the same time, but increased acclimation rates were not achieved when only one type of stimulus was used alone. This indication of genetic control over concentrations of glucose and the cell structure indicates that any substantial increase in frost hardiness must come through a mutation of the genetic codes either naturally or through labratory engineering.

#COMMERCIALIZATION OF OUR MARINE RESOURCES

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In general, my science proyect attempted to pursue the following objectives: 1. To motivate additional investigations of the agarofits by different branches of Science for the betterment of society, 2. Industrialization of the agarofits for the domestic market, meaning a great economic factor for the Island, and 3. Agarofits' preservation through artificial methods. Of all different types of agarofits that exist, I decided to use various species of Rhodophyta. It is found abundantly along the coasts of Puerto Rico: Gracilaria verrucosa, Gracilaria foolifera, Gracilaria curtisiae, Gracilaria debilis, Hypnea musciformis, and Bryothamnion triquetum. Before begginig the experiment, I studied each species very carefully. Then I designed a system of synkers to sow the specimens. An ecosystem as natural and real was created (in a pool) for the specimens. All of them adapted very well to the artificial ecosystem which sustained them and promoted their communal development. The species were obtained at various locations around the Island. All specimens were measured and weighted before and after their cultivation. After daily observation I could note that the species that most grew and adapted to my synkers system was the Gracilaria verrucosa. Then, I proceeded to determine which of the species would yield more agar per square meter of dry algae: It was the Gracilaria verrucosa. I discovered that my synker system can be useful.

#Fourth Award - General Motors ISEF/Botany

#PHASE THREE: THE EFFECTS OF ELECTROSTATICS ON THE CALLUS GROWTH AND DIFFERENTIATION OF DAUCUS CAROTA

Balac, Dragica, Gavit High School, Hammond, IN 46324
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Recently electrostatic energy has been used in various experimentation. For example, frogs which normally do not regenerate limbs have been found to after having been exposed to electrostatic energy. The purpose of my research was to find the effects of electrostatics in differing concentrations and at various levels of exposure time on carrot callus cultures.

Carrot discs of a 2mm thickness were cut from the cortex of the carrot and placed into Carrot Callus Initiation media. From this point, the cultures were either charged by a Tesla coil to provide a higher voltage or an electrostatic generator to provide a lower voltage. Each of the cultures was either charged for 1, 2, 4, 8, 16, or 32 seconds. Controls were also prepared.

Carrot callus that was produced without a charge of electrostatic energy was placed on Shoot Development Media and then charge. This was done to see the effects of electrostatics on the shoot development stage of callus.

The carrot discs were microtomed and viewed under a microscope to further substantiate my conclusion. The electrostatic energy affected the number of plastids within the cell. It decreased their number, therefore, also decreasing the nutrients within the cell since they are stored in the plastids. The energy also had an adverse effect on the cell wall of the carrot tissue. The strength of the cell wall gradually deteriorated to a point where the cell collapses. By using higher concentrations of the energy the process was just expedited. The energy affected the callus by decreasing the rate at which the tissue forms shoots and roots.

#Second Award - U.S. Air Force

VENUS FLYTRAP CLOSURE: THE ELECTRICAL FACTOR

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This project investigates the natural voltage present in the Venus flytrap (Dionea muscipula). It has been hypothesized recently that the voltage could cause the trap's acidity to increase, closing the trap.

This project, designed to show the function of the electrical voltage in the flytrap, was carried out in five phases: 1) by implantation of platinum electrodes, the voltage present during "normal" Venus flytrap closure averaged 5 millivolts; 2) traps were artificially stimulated in several ways, which showed that different stimulations cause varying voltages between 1.0 and 8.0 millivolts; 3) a 7.4 volt battery was attached to a flytrap, causing closure; 4) the pH of the traps was tested (after closure, the pH ranged from 1.0 to 1.5 less than before closure); 5) traps were tested in vitro in acidic and buffer solutions (the acidic solutions caused immediate trap closure, while buffering prevented closure).

Results led to the conclusions that the voltage in the Venus flytrap is directly related to the frequency of stimulation and that the voltage is a result rather than a cause of trap closure.

#PLANT COMMUNICATION

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When a plant is damaged a chemical reaction occurs within the leaves causing the production of tannin and phenol. Both tannin and phenol play a major role in a plant's chemical defense.

In 1983 Schultz and Baldwin determined that poplar raments and sugar maples communicated by the releasing of an airborne cue when damaged. The airborne cue caused neighboring trees to react in the same manner as if damaged.

In Phase I of the Plant Communication experiment Sweet Sorghum plants (Sorghum vulgare var. saccharatum) were determined to communicate with neighboring sorghum by the releasing of an airborne cue when they were induced with damage. The airborne cue caused a significant increase of both tannin and phenolic content in neighboring plants' leaves. Leaf extracts were analyzed using the Price and Butler visual estimation and spectrophotometric tests. Plant polyphenols are toxic to some fungal infections.

In Phase II of the Plant Communication experiment Colletrotrichum falcatum, a fungal pathogen, was introduced to sorghum which were previously exposed to damaged plants. The increase of phenolic content caused by plant communication inhibited the growth of the disease and was successfully used to control the disease.

The purpose of this experiment is to provide the agricultural industry with a natural defense to plant diseases by naturally stimulating antifungal compounds found in leaves.

#Third Award - General Motors ISEF/Botany

A THREE-YEAR STUDY OF AN ALLELOPATHIC KOLINE FROM POA PRATENSIS

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The initial phase of my experimentation was an investigation of allelopathic reactions with inhibitory responses to seed germination. I prepared an extract of water soluble chemotropic substances from the seeds of Poa Pratensis. Germination test using the allelopathic extract resulted in a definite inhibitory influence. The higher the concentration of allelopathic extract the more drastic was the reduction of germination. Smaller seeds are more sensitive to chemotropic agents.

The second phase was to experiment on any stimulatory influence of allelopathic agents. I used weak, one to two percent concentrations of the extract and compared these to a 10-15-10 solution of liquid fertilizer. Measurements were recorded to determine the average height of the different varieties of wheat seedlings tested. The weak concentrations initially did stimulate seedling growth; however, after seven to ten days all seedlings were equal in growth and development.

The third study was an investigation of chemotropic agents with emphasis on isolating the chemicals and determining their inhibitory influence on seed germination. The extract was concentrated by freeze-drying using liquid nitrogen and a rotary vacuum pump. The concentrated allelopathic inhibitors were then separated with various organic solvents on paper chromatography. The fractions were tested for inhibitory effects with radish seed germination. As attempts were made to purify the extract, there was gradual diminishing inhibitory activity. I concluded that the inhibitory biological activity was a result of either the threshold levels of chemicals in the extract or snyergistic effects of allelopathic chemicals.

# "Hormonal Control on Nodding before the Bloom and the Subsequent Erection in Pedicles of Erigeron Philadelphicus"

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Erigeron philadelphicus, a kind of fleabane, is an indigenous North American grass and now is widely distributed in Japan. This species, which is identifiable by its lovely pinkish flowers in early spring, can be found in fields and on roadsides in Nagaoka City, where I live. This plant attracted my interest by nodding before the bloom and subsequent erection in the pedicle of this flower. Why do these actions occur? What factors control these actions? After some trials, it was found that plant hormones played an important role in nodding and erection. I would like to describe here the results of my detailed studies.

Nodding of the pedicle did not occur when the bud was cut off. It is interesting to note that β-indole acetic acid(IAA) treatment of a pedicle which had its buds cut off induced nodding. However, this treatment was not effective on the pedicle when the roots of the plant were detached. These results suggest that gibberellin which is produced in roots, as well as IAA, participates in nodding. Simultaneous treatments on the budless pedicle with IAA, and on the rootless stem with gibberellin, were carried out. This treatment induced nodding of the pedicle, and the maximal effect was observed with a 10^{-3}M concentration of both IAA and gibberellin.

The erections were observed with any concentration of IAA. Gibberellin was found to have nothing to do with the erection.

These results indicate that nodding and the subsequent erection in pedicles of Erigeron philadelphicus are under the contrl of both IAA Produced in the bud and of gibberellin produced in the roots.

#Third Award - General Motors ISEF/Botany

THE UNUSUAL INSECTICIDE

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My original question was: if I put red food coloring in a plant's water, would the plant change color? I had a control plant and a variable plant (both Syngonium Podophyllum). I watered the control plant with tap water and the variable plant with specific amounts of food color mixed in with the water (see Log). The variable plant's color never changed. The interesting part of this project is that while treating these plants, I went into the greenhouse and I saw that the control plant was covered in aphids and spider mites. The variable didn't have one bug on it. For the next few weeks, I checked the plants, and the variable never had a bug on it, even though the control was so infested that it almost died. After making microscope slides of the stems of both plants, I noticed that the variable plants' stem slide showed the presence of more chlorophyll. In my chemistry class, I learned about pH levels. I bought two new plants and repeated the experiment, this time watering with distilled water and taking pH levels of the soil, stems and leaves. Both plants started at a 3.0 acidic level. As time went on, the control plants' level became more basic, while the variable plants' level became basic at a slower rate and eventually leveled out. The leaves and stems followed the same trend. Using the information I have found through experimentation, I will try to explain with my project why this phenomenon happened.

# The Fatal Nutrient Range of Fungi on *Hydrilla verticillata*

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A species of submerged aquatic vegetation, *Hydrilla verticillata* is now strangling the Potomac River. Covering over 1,900 acres, it is projected to grow to cover over 36,000 acres by 1995. One new method of stopping hydrilla being researched is the enhancement of indigenous microorganisms that produce lytic-enzymes as a biological control. A study was done by J. Pennington in 1985 who then further recommended that the level of nutrients needed by microorganisms to produce lytic-enzymes be studied. My experiment set out to quantify a range of nutrients in a fungal inoculum that would allow for maximum effaciousness.

Indigenous fungi from hydrilla on the Potomac River was isolated, cellulose positive isolates were grown in different nutrient dilutions, the fungi was visually identified as penicillium, and hydrilla sprigs were inoculated. The dilutions with the greatest amounts of nutrients killed the majority of their hydrilla sprigs. At the end of 35 days the dilutions with the least amounts of nutrients had not killed any hydrilla. The dilution which was 1:1 nutrient broth to water killed all of its hydrilla an average of ten days before the rest. By day 35, its average damage was significantly (.05-t-.02) greater than the other dilutions.

This experiment concluded that fungi do need a certain level of nutrients to produce lytic-enzymes and the optimum concentration of nutrients in a fungal inoculum to destroy hydrilla is 1:1 nutrient broth to water.

#First Award - Bureau of Reclamation/U.S. Department of the Interior

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THE EFFECT OF METHYLXANTHINE APPLICATION ON MUNG BEAN PLANTS

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Methylxanthine compounds have been identified in previous research as endogenous pesticides produced by plants such as coffee beans, tea leaves, and cocoa beans. Caffeine, a specific methylxanthine, is expected to be a commonly applied insecticide in the near future. This is attributed to its pesticidal properties. But no studies have been done as to the consequences of extensive methylxanthine application on plants. The purpose of my research is to determine what effect caffeine build-up has on a plant, specifically on mung bean plants. My hypothesis is that the mung bean plants will be adversely affected by the caffeine.

Five test groups were formed of six seeds each. The seeds in each test group were allowed to germinate. Then taking each group separately, with one test group as a control, 1.5cc injections of .5M, 1M, 1.5M, and 2M caffeine solutions were given to the remaining four test groups respectively. One week later this procedure was repeated.

Data was collected as to first emerging root length, coloration, texture and root proliferation. Graphical analysis was made of the collected data.

Several conclusions were reached concerning the application of caffeine: Caffeine 1) Retards root growth, 2) Promotes leaf discoloration, 3) Accelerates the loss of leaf moisture and 4) prevents multiple root proliferation. As a result of this preliminary study, I have found that caffeine build-up can be disastrous to the leaves and roots of germinating mung bean plants.

#How Leaf Canopy Position in Corn Affects Productivity

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Rural Route 2, Varna, IL 61375

"How Leaf Canopy Position in Corn Affects Productivity" is a project to see which leaves on a corn plant had the most influence on yield and stalk strength.

On July 20, I went out to the cornfield to my pre-selected plots and administered the treatment to the experimental plots. There were 3 different treatments applied and they were removing all but the top 1/3 leaves, the middle 1/3 leaves, and the bottom 1/3 leaves. Some plots I didn't do anything to and used these as my controls. On a later date I ran stalk strength tests on the outer two rows to all the plots. At harvest time, I handpicked the inside two rows of each plot, shelled the ears, ran moisture tests, weighed the grain, and adjusted the weights accordingly.

My results are that the middle 1/3 leaves contributed to the yield the most while the bottom and middle leaves supported the stalk strength the most.

#Fourth Award - General Motors ISEF/Botany

MINIMUM PHOTOPERIODISM ON TOMATO PLANTS

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Problem: What is the minimum amount of sunlight needed to grow Tomato Plants?

Hypothesis: This study was initiated to look at the minimum amount of light needed to grow what is considered to be long-day plants. I believe that tomatos should be able to grow healthily with a minimum of 12 hours of sunlight, everyday.

Procedure:
1) Researched photoperiodism on various plants.
2) Germinated tomato seeds for experimentation.
3) Transplanted seedlings to growth chamber.
4) Experimented with photoperiod over a 12 week period.
5) Analyzed data and converted to graphic comparison.
6) Compared recent data, with previous data.
7) Completed abstract.
8) Built and completed display.
9) Presentation.

Observation: See display board.

Conclusion: With respect to the critical period in flowering plants, I found out that the more sunlight tomato plants are exposed to, the better they will grow. They may be exposed to as little as 16 hours of sunlight per day, and still be able to grow healthily.

Application: This information may be used for farming in the different temperate zones. It may also be adequate for people who wish to regulate the amount of sunlight to which their tomatos are exposed, and possibly get fruit set. This information resembles previous data I have collected. Which also implied that an abundance of sunlight is a necessity for the maximum amount of plant growth.

Will Early Growth & Germination Improve Purple Hull Pea Production?

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The purpose of this research was to prove that early germination and growth will increase the production of purple hull peas. A second purpose was to test for a use of detergent water from laundering clothes.

In phase one of this research, peas were microwaved for 0, 15, 30, 45, and 60 seconds and planted in pots. The peas that were microwaved for 15 seconds germinated within 24 hours and grew taller in a shorter amount of time than the other tested groups.

In phase two, pea seeds were divided into 5 groups. Each group was microwaved as before and stirred during microwaving to insure even radiation. Two, 200 feet rows of each of the groups of seeds were planted. One row of each group was watered with a phosphate-containing detergent water and the other row was watered with plain water. Records of germination, height and production were recorded.

The data collected indicated that plants microwaved 15 seconds germinated within 24 hours as did the laboratory plants in phase one. They were 7½" taller than the control and produced twice as many peas. Those microwaved 15 seconds and watered with detergent water were 8 7/8" taller than the control and produced over twice as many peas.

In rainy areas, quick germination will prevent washing away of seeds. By microwaving seeds for 15 seconds before planting quick germination will result. 16.4% more beans were produced on the detergent treated rows. On a large scale this could amount to a sizable production. This use of waste water would also help in dry regions where water must be conserved.

There is definitely a link between early germination and production.

#NUTRIENT DEFICIENCY AND PIGMENT COMPOSITION: Is there a correlation?

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The idea of this project started when I read an article saying that one of the major problems farmers face is identifying the exact problem with their crops when they see foliar deficiency symptoms. Puzzled, I researched ideas for solutions to this problem. Through my reading, I found out that numerous pigments are present in leaf samples; thus, I hypothesized that perhaps plants were like humans and they produce or change pigment composition during illness, somewhat like how our own bodies produce more white blood cells when we are sick. So perhaps the pigment composition would change enough when suffering from an elemental deficiency that the composition would allow for accurate identification. With these ideas in mind, I developed a procedure to test this whole concept. Basically, the first step was to produce deficient plants hydroponically, while following a revised version of "Hoagland's solution." Next, I extracted the pigments of specific leaves, for testing, by boiling them in alcohol. Then, I analyzed the pigment composition of the samples. For the analysis, I chose the method of determining composition from absorption spectra and the spectrophotometer, because of its accuracy in data. The results from the spectra were then analyzed; and, I found that my prediction was basically correct. A plant will alter its pigment composition in a pattern characteristic to the deficiency. As a result, I have found an accurate means of determining plant health and have partially solved the problem faced by the farmers, which was mentioned earlier.

#Fourth Award - General Motors ISEF/Botany

HOW MUCH OF A COTYLEDON IS NEEDED FOR A PEA EMBRYO TO GROW?

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The cotyledon is that part of the seed which provides nutrients for the developing embryo before it sprouts leaves and can sustain itself through photosynthesis. The purpose of this project was to determine the minimum amount of a cotyledon needed for a pea embryo to grow with leaves.

Pea seeds were soaked in water for 24 hours prior to manipulation to hasten germination. The seed coat was removed and the weight, length, and volume of the seed were ascertained. In individual seeds varying proportions of the cotyledon were removed in decrements of eighths resulting in embryos with amounts of the cotyledon ranging from none to intact.

The weight, length, and volume of the seed were again obtained to quantitate the amount of the cotyledon actually removed. The seeds were placed on water-saturated paper towels in petri dishes and the growth of the root and shoot were recorded daily. On day eight and at four day intervals thereafter drawings were made of the developing embryo.

In each of two experiments, no seed possessing less than 3/8ths of the cotyledon grew leaves while every seed with greater than or equal to 3/8ths cotyledon did grow leaves. As plants with a smaller cotyledon also have a smaller root system, these results raise the possibility that food fields might be increased by planting a greater number of seeds with a smaller cotyledon per unit area.

USAGE OF WASTE PRODUCTS AS NATURAL INSECTICIDES

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Purpose: Is to find a natural insecticide which could be made from a waste product such as fruit peelings. I would like to find not only a safer but cheaper insecticide that would be more effective.

Procedure: I selected navel orange, orange, lemon, lime, tangerine, white and pink grapefruit, kiwi, avocado, and banana peelings. Using the very outer layer of skin to prepare the insecticide. Marigold stems and limonin were also used. I took 50g of the peelings or stems and added 150ml of distilled water. Blended until liquified and set for 24hr. Strained and heated. I prepared the store products by adding 75ml distilled water to 25ml of the product. Total 18 insecticides. I chose 3 dosages and did 3 tests for each dosage on the mealworms, house crickets, jewel wasps, and fruit flies. I recorded the time from contact to immobilization. I used the Kirby Bauer method to see if the insecticides could be used as a bactericidal agent. Ranked according to the inhibition zone and took pictures.

Conclusion: I found that Team and alcohol were the best store products and tangerine was the best natural insecticide as a bactericidal agent. I would recommend Red Spider and Mite Spray for a store insecticide and pink grapefruit for the natural insecticides. Finding uses for waste products is becoming more and more common each day. Hopefully in the future waste products could be used for something such as an insecticide. It may not only be cheaper and safer but also more effective.

#Fourth Award - General Motors ISEF/Botany

THE EFFECTS OF SEAWEED EXTRACT ON LYCOPERSICUM ESCULENTUM DEVELOPMENT

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This project was performed to determine if a liquid extract of the seaweed Ascophyllum nodosum could be used to improve the germination and growth of tomatoes. During phase one, a study was conducted to determine the effects of the extract on seed germination. A commercial grade seaweed extract concentrate was used in three diluted forms to treat 768 seeds of the New Yorker variety. The results showed a significant increase in early seed germination in all three of the test groups.

During phase two, foliar seaweed treatments on 192 Hayslip tomato seedlings were conducted to determine its effects on height, stem diameter, the number of leaves, fresh weight, and dry weight. The extract was maintained at a constant concentration, but the number of sprayings per group was varied. Measurable increases were recorded in all areas of the test.

Phase three was a continuation of phase one. The procedure used to test the seed germination was improved to provide more accurate results. In addition, 1024 seeds of the Hayslip variety were used instead of the New Yorker variety and the extract concentrations were changed. The results showed a significant decrease in seed germination at the highest concentration but no other significant results were found.

#A STUDY OF FACTORS AFFECTING THE GROWTH OF CROWN GALL (PLANT CANCER) ON HELIANTHUS CAUSED BY AGROBACTERIUM TUMEFACIENS

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Crown gall is a disease caused by Agrobacterium Tumefaciens. This disease affects numerous dicot plants, forming tumorlike galls on the roots or stems of many species of plants. This disease is of economical importance because of the number of crops destroyed each year.
PURPOSE: To study crown gall is to find a cure for it. Last year's study consisted of answering questions on the best growth site for crown gall on Helianthus (sunflowers). This year I expanded my study to the effects of Aloe Vera on the growth of tumors caused by crown gall.
QUESTION: If seeds are allowed to imbibe selected solutions, will the plants have a resistance to the causative bacteria Agrobacterium Tumefaciens? PROCEDURE: The solutions selected were Streptomycin, Vitamin B_1, and Colchicine. A control consisted of distilled water. The seeds were placed in the solutions until the radical emerged from the seed coat. The seeds were then transferred to soil for germination. Watering of the plants consisted of watering with the selected solutions and the control with water. After three weeks of growth, the plants were inoculated with the bacteria. Growth rate and tumor size were carefully monitored.
HYPOTHESIS: There will be no difference in the growth of the tumors when the seeds are allowed to imbibe selected solutions.
CONCLUSION: The tumors appear to be decreased, especially in the groups of Streptomycin and Colchicine. The "T" test was done to verify my results. My hypothesis was incorrect except for the tumor growth of the Vitamin B_1 plant group.

#Third Award - General Motors ISEF/Botany

#MUSK THISTLE CONTROL

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In Utah $200 - $300 thousand is spent to control Musk Thistle, and most experts believe it cannot be controlled. I set up an experiment to prove it can. I located two areas highly infested with Musk Thistle and determined eight 10X10 plots. Within each plot the four developmental stages (First Pink , One-half Red, Full Red, and Bullet) were marked. Each plot was treated with standard amounts of *Amatrol; *Banvel; *2,4-D; *Amatrol + Banvel; *Amatrol + 2,4-D; *Banvel + 2,4-D; *Amatrol + Banvel + 2,4-D; * No Spray. When the appearance of first seed dispersal was noted, the heads were gathered and seeds removed and placed in petri dishes. The seeds were then germinated (one-half in the Utah State University Lab and one-half in the Richfield High School Lab) by placing 50 seeds in petri dishes on germination pads. The incubator was set at 30 degrees C. and seeds were daily checked to assure moisture and to calculate germination. The percentage germination for each treatment and stage of development was determined and the results from the labs were averaged. RESULTS: Compared to the control, which had a 59.5% germination, Musk Thistle sprayed at any stage of development with any chemicals used had 50.8% less germination. In the First Pink, One-half Red, and Full Red stages, treated with any of the chemicals, the germination percentage is as follows: *Control = 88.25%; *Amatrol = 32.75%; *2,4-D = 68.25%; *Amatrol + Banvel = 20.25%; *Amatrol + 2,4-D = 68.25%; *Banvel + 2,4-D = 27.50%; *Amatrol + Banvel + 2,4-D = 17.00%. Total control of Musk Thistle can be achieved in ten years if annual treatments of Amatrol + Banvel + 2,4-D are applied. Yearly cost of spraying will decrease uniformly and after ten years when control of Musk Thistle is achieved Utah can save $200 - $300 Thousand.

#Fourth Award - General Motors ISEF/Botany

THE EFFECT OF ACID RAIN ON THE *PHASEOLUS LIMENSIS* SEED

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Acid rain is a very serious problem, it damages plants, lakes, rivers, and even buildings. The title of my project is *The Effect of Acid Rain on the Phaseolus Limensis Seed*. *Phaseolus Limensis* is the scientific name for the lima bean.

The problem I set out to solve was "What is the effect of different pH levels of simulated acid rain on the germination and growth of the *phaseolus limensis* seeds." The hypothesis made was that some of the seeds would thrive while those given water with a low pH level would not germinate well and not thrive at all.

To conduct this experiment a pack of *phaseolus limensis* seeds was needed. After planting one seed in each section of the pots they were all put under a florescent light for eight hours a day. Each seed was given twenty drops of water every day for twenty-one days. Each pot was given water with a different pH level.

During the twenty-one day period the pots were closely observed. The germination periods and the growth of each plant was recorded daily after germination.

By the end of the twenty-one day period none of the seeds given simulated acid rain water had germinated. The seeds were dug up and examined. It seemed that the seeds given water with a lower pH level were not as developed as the ones given the water with a slightly higher pH level.

The hypothesis was disproved. Many things could have gone wrong. If this experiment was to be conducted again I would probably change many things.

CHEMISTRY

THE EFFECTS OF VARIANT CONCENTRATIONS OF KIO$_3$ IN BRIGGS-RAUSCHER OSCILLATING REACTIONS

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This investigation explored the significance of the negative iodate ion in an iodine clock reaction. A composite formula for a B-R reaction was calculated, and based on research, a molarity of 0.27 was chosen as the basis for my variations. A set of three colorless solutions was prepared: one consisting of H_2O_2, another consisting of Mn^{+2}, malonic acid and soluble starch, and a third composed of sulfuric acid and potassium iodate. These three solutions were combined, stirred, photographed, and observed. Color changes from blue to clear to yellow and back to blue again took place. These color changes proceeded to happen for an average of three minutes. Rates of oscillation and temperature measurements were recorded. Alkalinity and electrical potential was considered in later experiments.
Primary Conclusions:

1) The concentration of the KIO$_3$ is directly proportional to the amount of thermal energy produced.
2) The concentration of the KIO$_3$ is indirectly proportional to the time before oscillations began and the comparible clarity of the initial solution.

COMPARATIVE EFFECTIVENESS OF DISSIMILAR COAL DESULFURIZATION METHODS

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The purpose of this study is to compare two dissimilar methods of desulfurizing bituminous coal on the basis of heating value and sulfur content. Coal is desulfurized prior to combustion in order to decrease the amount of sulfur compounds formed as by-products of the combustion process which are major contributors to air pollution. However, total desulfurization is expensive and causes significant reductions in the heating value of coal.

Compared are traditional acid washing methods and an experimental method. The experimental method involves separation of the components of the heating value of coal from its impurities by explosively fracturing coal using carbon dioxide at super critical temperature and pressure. Hypotheses were 1) the heating value of acid washed coal will vary inversely, and 2) the heating value of super critical CO$_2$ fractured coal would vary directly with percentage of sulfur removed from the coal, and 3) the heating value of the CO$_2$ fractured coal will be higher than the acid washed coal.

The acid washing method involved adding HCl and HNO$_3$ to coal. The second method involved reacting coal and carbon dioxide at 31.1°C and 1000 psi, then releasing the pressure causing the coal to fracture. Results from these experiments showed that the CO$_2$ separated coal had a slightly higher heating value and approximately one-fourth as much sulfur as the acid washed coal. Thus, my hypotheses were confirmed.

The significance of this project is that it suggests carbon dioxide may more thoroughly desulfurize coal without reducing its heating value as much as acid washing.

A TWO YEAR STUDY OF CAFFEINE AS A POSSIBLE NATURAL OCCURRING PESTICIDE

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The natural function of caffeine in plants has been a mystery, even though it has been used for centuries as a stimulant by millions of people. Despite all of the research that has been done on caffeine in mammals, no one has ever determined why it is present in plants Over time, plants have developed certain defenses to protect themselves against insects, and research suggests that caffeine might have been present for that purpose as a natural insecticide.

Current research in the science field is coming close to proving that plants produce these substances to discourage insect feeding. The methylxanthines, including caffeine and theorphylline, are found in berries, seeds, coffee, cocoa, and kola. These substances produced by plants include specific toxins, compounds with pheromone-like activity, and bitter-tasting aversive substances. This research has shown that caffeine can be used as an effective pesticide against the *Manduca sexta* (Tobacco Hornworm).

Each year farmers and growers in the United States lose countless numbers of tobacco, tomato, potato, and eggplant crops to the destructive *M. sexta*. This insect is potentially the most destructive insect pest of tobacco. It chews irregular holes in leaves and often feeds along the leaf margins. The devastation of crops caused by the *Manduca sexta*, in different stages of their life cycle, were given caffeine in a concentrated form. The concentrated forms affected the life cycle of the insect. At low concentrations, such as .005 M, it simply inhibited the insects' growth. At higher levels, 3.1 M, it killed the insect. This research is the beginning of a long term experiment to show that caffeine can be used as a safe and effective pesticide.

# DETERMINATION OF ROTARY POLARISATION IN SODIUM CHLORATE CRYSTALS

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Crystals have been admired by man for as long as he has appreciated beauty. They are among the most beautiful phenomena in nature. For centuries, scientists and crystal-gazers alike have been fascinated by their sharp lines and angles and their deep and brilliant colors. Now artificial crystal production has become a major part of our technilogical society. However, like all sciences there is still a lot to learn about crystallography, the doctrine of crystallization.

In the past three years, this researcher has studied crystallography, and has performed many experiments to back what he has learned. After studying the phenomenon known as rotary polarisation, this researcher set out to prove if the randomness with which right-handed and left-handed seeds of sodium chlorate form in a solution might be upset by suitable influences, and if the strength of this influence would cause a change in this apparent randomness.

This researcher grew crystals of sodium chlorate, and using microscopic examination, he determined the hand of a section and the specific rotation at particular wavelengths for each seed crystal. By comparing this information with crystals grown without any apparent influence, this researcher determined using statistical analysis, if there was a significant difference among the control and experimental sodium chlorate crystals.

This researcher hopes that the results found in his study may prove to be helpful to scientists who are trying so desperately to continue expanding our knowledge and technology as we have been doing in the past 2000 years.

#First Award - U.S. Navy
Second Award - General Motors ISEF/Chemistry
Alternate to Scholarship - U.S. Marine Corps
Alternate to Scholarship - U.S. Navy

AN OPTICAL ANALYSIS OF SACCHARIN CONTENT IN SODAS FROM DIFFERENT GEOGRAPHICAL REGIONS

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In this age, with threats of incurable diseases, the reduction of health hazards is very important. Since the discovery that saccharin causes cancer in laboratory mice, a new artificial sweetner, aspartame has been widely used.

The purpose of this project was to determine, optically analyze, and compare the saccharin content in sodas from various geographic areas. Sodas were obtained from Indiana, New Jersey, New York, North Carolina, Pennsylvania, Tennessee, Colorado, District of Columbia, Argentina, Jamaica and Africa.

This project also tested the validity of project labels that state "saccharin free" and "100% NutraSweet".

A technique reported in 1983 by Ramappa and Nayak, that extracts saccharin from pharmaceuticals and food products was used.

A spectrophotometer, solutions of sodium saccharin, and an aqueous solution of Azure B dye were used for the calibrations. The Azure B/Saccharin Complex Extracts were prepared from each soda using a series of chloroform, ether, buffers, acids, and bases. The spectrophotometric analyses from this project demonstrated the presence of saccharin in those sodas tested and labeled "100 % NutraSweet" and those labeled "Saccharin Free". Negative saccharin determinations were found in those non-diet sodas containing sugar.

My 1985-86 research centered on determining the amount of saccharin in various food products. This year, I decided to further my investigations by testing "saccharin free" sodas from different locations.

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* SENSITIZED VALENCE PHOTOISOMERIZATION OF NORBORNADIENE TO QUADRICYCLENE

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The purpose of this project is to investigate the efficiency of various aromatic ketones on the valence photoisomerization of norbornadiene to quadricyclene. Since norbornadiene does not absorb ultraviolet wavelengths to an appreciable intensity on earth, the isomerization requires the use of a photosensitizer, a compound which absorbs greater-intensity wavelengths and transfers the energy for the isomerization to the lowest energy triplet state of the norbornadiene.

1.0m solutions of the sensitizers acetophenone, benzophenone, and fluorenone were made and samples were added to hexane to make 2.0M solutions. Two different sets of irradiations were performed on samples using a 15W Hg vapor lamp and a 15W UV lamp, respectively. NMR and v.p.c. analyses were used to determine the structure, conversion rate, and purity of quadricyclene produced. Spectral absorption of samples was measured with the use of UV/visible absorption spectroscopy.

Acetophenone had the greatest conversion rate(4.2×10^{-3} moles/100 hrs.) and (8.3×10^{-4} moles/100 hrs.), respectively, in both irradiations. Benzophenone had conversion rates lower than acetophenone, while fluorenone had no measurable conversion in either test. No observable side products resulted from the isomerization: the isomerization proceeds with a high level of chemical specificity. Spectral absorption of sensitizers was limited to the UV spectrum with these approximate maximum absorption values: acetophenone-305nm, benzophenone-310nm, and fluorenone-340nm. Therefore, there appears to be no direct interdependency between triplet state energy transfer and spectral absorption of sensitizers.

*Fourth Award - General Motors ISEF/Chemistry

BRIGHT CHEMISTRY: A PHOTOMETRIC STUDY OF CHEMILUMINESCENCE

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Although the primary use of chemiluminescence is presently that of entertainment, chemiluminescence is very useful in situations where there is no electricity, where light is needed but there is an explosion hazard. A prime example of chemiluminescence is found in the familiar CYALUME lightsticks seen around Halloween. Lightsticks are compact, have a shelf life of 3 to 5 years, and can be activated instantly. They are now found in the emergency kits of most planes and boats. They produce no spark or flame, and when activated do not become more than a few degrees warmer than their surroundings.

To study the properties of chemiluminescence and phosphorescence under varying temperatures and over time, I constructed a photometer, an electrical circuit that measures light intensity. Based on my experiments, I have come to the following conclusions:

1) At a constant temperature, the decay of light intensity emitted from a CYALUME lightstick follows the curve $\text{Luminosity}=\log(K/\text{Time})$
2) At a constant temperature, the decay of light intensity emitted from the chemiluminescent liquid TMAE (tetrakis(dimethylamino)-ethylene), follows the curve $\text{Luminosity}=K/\text{Time}$
3) At a constant temperature, the decay of light intensity emitted from Sun-Lite^{tm} phosphorescent paint follows the curve $\text{Luminosity}=\exp(K/2t)$, where t represents the time elapsed
4) The effect of temperature on these phenomena also varied, from demonstrating no effect to the ability to suspend the reaction.

#A CHEMICAL STUDY OF THE LEAD CONTAMINATION DEGREE IN LEPUS CUNICULUS FED WITH PANICUM MAXIMUM L. GROWN ALONG THE ROADS OF SOUTHWESTERN OF PUERTO RICO: MAIN REFERENCE TO THE ADVERSAL EFFECTS ON ITS FOOD CHAIN

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In Puerto Rico thousands of cars are driver in the streets, these cars eliminate carbon dioxido, which comes from gasolines that are formed by chemical agent like lead. This dioxido affect flora and fauna a much. This problem awakened lots of interest in me; thats why we decided to make an investigation toward it, to find out if. The percentage of lead in the vegetation varies according to the transits that pass on the roads. Also to investigate if the lead can be maintained through a food chain. From the adjacent vegetation of the roadside. We picked the most common grass from the roads Panicum maximum L. different roads. The highway #2, representing the one of more transit and highway #362, of least transit, also representing the control. The used grass would be of a far life from the road. These 3 group of grass will be fed to 3 different groups of rabbits, with three rabbits each group representing the 2 different roads and the control. Before starting the investigation, the rabbits hair was analized to know if they had a trace of lead, but there was no presence of any found in not one rabbit. After a month of feeding an the contaminated grass, two groups of rabbits and the last one were fed with the control of grass. Obtaining the results by Atomic Absortion Analysis it was found that highway #2 contained a higher quantity of lead, highway #362 a lesser quantity of it, and the control was lead free. Two months later, the same analysis was performed and the same results were obtained. In this third analysis an analysis of the groud soil was included from 3 station, revealing that highway #2 possesed the highest quantity of lead, highway #362 a lesser amount and control a presence of almost none. The results obtained have surprized me so much. That on future proyection, we have decided to investigate on if lead, through that food chain can reach the human being.

#Fourth Award - General Motors ISEF/Chemistry

THE EFFECTS OF PERMANONE AND DEET ON LONE STAR TICK

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Pressurized sprays of commercially available permanone or deet at 20 and 30% concentrations applied to military field uniforms were evaluated as protectants against *Amblyomma americanum*. A one-minute application of permanone to the exterior surface of the army material provided 100% protection against attack by the larval stage of the tick, while one-minute applications of 20 and 30% deet provided 86 and 92% protection, respectively.

A COMPARATIVE STUDY OF PROTEIN DENATURIZATION BY MICROWAVE IRRADIATION AND THERMAL HEAT

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Technological advancements have created many new appliances in today's revolutionary world. The majority of the public readily accepts these advancements as safe and efficient. One such advancement that has become a household appliance in America is the microwave oven.

This project was conducted to compare microwave irradiation's effectiveness in denaturing proteins with that of thermal heat. The enzyme pancreatin, the model protein, was exposed to various temperatures resulting form microwave irradiation or thermal heat. The enzyme's activity rate was then checked by reacting the enzyme with starch and running a reducing sugar assay upon it. The activity rates of the microwave irradiated and thermal heat treated enzymes were compared to determine the effects upon the enzyme.

The microwave irradiation decreased the enzyme's reaction rate 97.57% more than the thermal heat at 37 C. At the temperature 56 C, the microwave irradiation caused a 94.04% decrease in activity compared to a 63.52% decrease by thernal heat. These results indicate that not only is microwave irradiation more effective than thermal heat in denaturing proteins, but it also begins denaturing at a lower temperature than thermal heat.

#CHROMATOGRAPHIC SEPARATION OF DYE SYSTEMS

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These experiments are designed to separate dyes by using a mobile phase and passing it through a stationary phase of lesser density. The system, Counter Current Chromatography(CCC), works by winding tygon tubing around a piece of wood rounded off at the sides and using broken burets and other readily available glassware. The coils are filled with the stationary phase(n-butanol saturated with K_2HPO_4) and then the dyes are injected. The mobile phase(K_2HPO_4 saturated with n-butanol) runs through the stationary phase carrying the dyes and separating them. The dyes used are Chlorophenol Red, Eosin B, and Naphthol Green. All solutions are made in volumetric flasks and massed out on a Sartoris Balance. Data are obtained by collecting the fractions of separated dyes and performing spectral analysis on a Perkin-Elmer Spectrophotometer. The results show that separation is achieved. The Naphthol Green separates first, then the Chlorophenol Red, and the Eosin B last. Chromatic paper may also be used to confirm the order and the purity of the separated dyes. In conclusion, dyes may be separated by using CCC. It can be an efficient way of separating other dyes such as Fluorescein and Dichlorofluroescein, depending on the polarity of the dye and the polarity of the solvent used in the mobile phase. In the future, CCC could find application in the separation of natural products, industrial components, or pesticides.

#Honorable Mention - American Chemical Society

MATHEMATICAL MODELING FOR THE BEHAVIOR OF SURFACTANTS IN SOLUTION

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The purpose of this project was to mathematically model the behavior of surfactants in solution. Surfactants are molecules comprised of ionic hydrophilic heads and hydrophobic hydrocarbon tails. In concentrated solutions surfactants tend to collect with their tails together in groups called micelles which act as strong detergents. Critical Micelle Concentrations (CMC), the concentrations at which micelles first begin to form, were found experimentally for both pure solutions and solutions with added inert salts by using conductivity and surface tension titrations. The CMC was found to be proportional to temperature and hydrocarbon tail length and inversely proportional to inert salt concentration. Several mathematical models were constructed and analyzed. The most successful model assumed: 1) that the micelle had a spherical shape, 2) that the hydrocarbon tail was flexible, 3) that the maximum number of molecules allowed in a micelle was dependent on the physical properties of the surfactant, 4) that the micelle was formed in an approximate spherical shape by the addition of one molecule at a time, and 5) that a separate equilibrium constant, K_{eq}, existed for each type of micelle containing n molecules. The K_{eq} was assumed to be dependent on: 1) the hydrophobic surface energy of the hydrocarbon tail, 2) the repulsion between ionic heads, 3) the concentration of inert salt in solution, 4) the temperature of the solution, and 5) the physical properties of the micelle. Using the average number of molecules collected in a micelle at each surfactant concentration, this model will accurately predict the CMC for any type of surfactant from its physical properties taking into account the temperature and salinity of solution.

#Fourth Award - American Chemical Society
Fourth Award - General Motors ISEF/Chemistry

METALLIC CRYSTALS

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A knowledge of the properties of crystals, their internal structure, and the conditions affecting their development is of great economic and scientific importance.

The investigation involved a photographic analysis study of the size and character of metallic crystals under low voltage in a unit cell (closed and open). Saturated solutions of metallic nitrates and chlorides were used in the cells. Power sources of 4.5V, 5.5V, 8.0V and 8.5V were selected as the low voltage range.

The formation of crystals at the electrode or at distances from the electrode gave evidence of the strength of the metallic bonds. In contrasting the same solution through voltage changes in open cell units and closed cell units, increasing the voltage increased the rate of formation, in general. However in contrasting the open cell with the closed cell, same solution, evidence of interference with crystal formation was observed in the closed cell. Perhaps pressure build-up in the closed cell is the cause of the interference, but further investigation would be needed.

Since the size and character of the crystals formed in alloys determine the properties and qualities of the product, a study of metallic crystal formation is important in understanding alloy characteristics.

#Development and Testing of an Ultraviolet Dosimeter

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The harms of ultraviolet radiation are not to be ignored. Indeed many occupations are daily exposed to unhealthy amounts of ultraviolet radiation. With this in mind, I developed and tested a personal ultraviolet dosimeter which man eventually be used in the workplace to detect overexposure to ultraviolet light. The specific apparatus I used involves an organic compound, Methyl Ethyl Ketone (2-butanone), contained within a quartz tube. When exposed to ultraviolet radiation, the MEK undergoes a series of chemical reactions to form the products methane, ethane, and ethylene. By measuring these products, a relationship was found between the dosage and the products of the reaction. Using this relationship, one can tell directly the extent of exposure by checking the products. With these tests accomplished successfully, I hope to have developed an operational and useful dosimeter.

#Second Award - General Motors ISEF/Chemistry
Second Award - Patent and Trademark Office/U.S. Department of Commerce/
Patent and Trademark Office Society

EFFECTIVENESS OF ANTACID TABLETS

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The purpose of this experiment was to determine the relative effectiveness of antacid tablets. Several over-the-counter antacid medications were used. The amount of stomach acid that these medications could neutralize was determined by the titration method. In the experiment excess simulated stomach acid is added to the antacid. Much of the acid is buffered by the tablets and the remainder is neutralized with a standardized base. The difference between the amount of acid added initially and the amount neutralized by the base equals the amount absorbed by the tablets.

DYNAMICS OF POLYATOMIC MOLECULES

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Linear vibrations in four-atomed molecules were simulated by using a realistic potential called the Morse function to derive equations for the position and velocity of each atom. These equations were then numerically integrated by a computer using the predictor-corrector method. This model enables one to calculate the time of bond dissociation, test the stability of closely related equations, and determine the rate at which energy travels from one side of a molecule to the other. This simulation provides good insights into molecular dynamics which is intimately related to chemical reactions.

#Scholarship - The Ohio State University
First Award - U.S. Army
Fourth Award - General Motors ISEF/Chemistry

A TWO-YEAR STUDY OF COMPLEX FORMATION

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Many transition metals (e.g. Cu^{+2}, Ni^{+2}, Zn^{+2}, Cd^{+2}) form complex ions with ammonia. The purpose of this two-year investigation was to study copper (II) complexing. This year, the distribution coefficient of ammonia in water and chloroform was used in an indirect method of determining the formula of a copper ammine complex. The effects of varying concentrations of ammonia on complex formation were also studied. The major findings of this research included the value of the distribution coefficient of ammonia in the two immiscible solvents and the formulae of the copper ammine complexes for varying concentrations of ammonia. The crystal field splitting energy associated with the complex was determined by spectral analysis. Also, measurement of pH during the destruction of the copper ammine complex led to the discovery of a relationship between the pH and the number of NH_3 ligands bound to the metal.

THE THERMODYNAMIC EFFECTS ON OSCILLATING CHEMICAL REACTIONS

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My research was to determine it pressure and temperature has any effect on oscillating chemical reactions. Several series of tests were used to obtain the results. A vacuum chamber and a pressure chamber were used to study the effects of pressure on the reactions. Also, the tests were run at different temperatures to observe the effects on the reactions. I also used two different mediums in the research that I did. They were non-nutrient agar and filter paper. Thermodynamics effect oscillating chemical reactions greatly. In my research I got outstanding results. The two different mediums showed great change. The oscillating reactions were obtained from the following solutions: 1. Sodium Bromide, 2. Malonic acid, 3. Sulfuric acid, 4. Ferrion, and 5. Solid Sodium Bromate. Several concentrations of each were tested to obtain the best reactions.

Natural Indicators of Acids and Bases

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The purpose of this project was to test different flowers whose extract dyes could be used as acid/base indicators. Red roses, yellow roses, red camellias, purple tulips, rust chrysanthemums, pink pom poms, and yellow alstromeria lilies were the flowers used for the experiments. The flowers were each processed using the same procedures. The pigment of the flowers' petals was first extracted by soaking them in ethyl alchohol for twenty-four hours. Each flower was then titrated in four ways at different pH levels. Many different colors were seen at certain titration points. Indicator ranges were determined for each extract. There were interesting correlations between the different extracts which was due to their chemical similarities. Temperature stability tests were conducted on the extracts. Thin layer chromotography were also conducted on each extract.

CHEMICAL ANALISIS OF *ARTOCARPUS ALTILIS* LATEX

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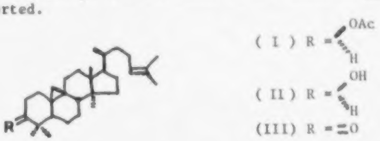
The purpose of doing the research on the latex of *Artocarpus altilis* is to indentify its chemical components, since this work has never been done by chemist in Puerto Rico.

The latex was contained in the sap collected from the bark of the tree of *Artocarpus altilis*. It was insolated and purified following the procedure reported by Kassner. The following chemical analisis were performed on samples of the latex: (1) T.L.C. - Thin layer chromatography (2) Colum chromatography (3) I.R. - Infrared spectroscopy (4) M.S. - Mass spectroscopy (5) $^{+}$H N.M.R. - Proton Nuclear Magnetic Resonance.

It was discovered that the latex from *Artocarpus altilis* contains important and useful chemical compounds known as sterol and steryl acetate. The sterol reported in the bibliography are not the same kinds of sterol and steryl acetate found in the latex of *Artocarpus altilis* as reported.



Cycloartenyl acetate, Cycloartenol and Cycloartenone in the bark of Artocarpus altilis. Gowsala Pavanasasivam and M.U.S. Sultanbawa Phytochemistry, V.12, 8May 1973 (Recd), page 2725-2726

THE EFFICACY OF VARIOUS SUNSCREEN AGENTS AS DETERMINED BY SOLUTION ABSORPTION SPECTRA

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Melanin produced in the human epidermis usually provides inadequate protection for skin exposed to the ultraviolet rays of the sun. Absorbing agents are applied so that these rays cannot cause damage to vital cells underneath the stratum corneum. The sunscreen agents P-aminobenzoic acid (PABA), oxybenzone, and octyl dimethyl PABA (Escalol 507) absorb certain amounts of ultraviolet radiation within the range of 290 to 350 nm (UV-B), that area which most easily causes erythema-or redness-on human skin. To relate the effectiveness of each chemical on a comparative graph, an investigation was set up using the Perkin-Elmer Lambda 4B scanning spectrophotometer, an instrument capable of evaluating within the desired wavelengths. The products were placed in a 0.005 g/L ethanol solution for analysis. Plotting absorbance (A) versus wavelength, the spectrophotometer scanned each sample separately in respect to a reference established by the solvent. The results were printed in an overlay of the samples so that comparative effectiveness could be readily gained. The Escalol, peaking above 3.0 A, was found to have far greater efficacy than the other two products. Even PABA, which peaked at 1.75 A but was predicted to be completely absorbent in ethanol solution, could not match this commercial derivative. In addition, the Escalol had the greatest intensity of absorbance within the UV-B range. Therefore, in the conditions stated, Escalol 507 would be most effective in the protection of human skin. This useful procedure becomes critical in the selection of agents for sunscreen products placed on the market.

ARE YOU USING THE BEST SHAMPOO?

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All shampoos were measured for viscosity, dirt removal, pH, solid content, price/unit volume, and distillation of each was completed. Ingredients of each shampoo were listed and compared to the others. Suave, Conair, Vidal Sassoon, and Flex were found to be the best shampoos for cleaning and price. Each shampoo that would clean best had an average pH of about 3. Overall, the top four shampoos were among the best buys. Relative viscosity does not effect how well the shampoo cleans. The shampoos ranged from 12.0 percent to 35.5 percent solids, which indicates that the shampoos had a high liquid content. The shampoos which were chosen as the best shampoos - Suave, Conair, Vidal Sassoon, and Flex - had a lower percentage of solids present than the other shampoos tested. Some of the top name brands and more expensive shampoos proved not to be among the best in the testing.

AN INVESTIGATION OF CRAB SHELL KINETICS

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This investigation involves the experimental determination of the activation energy of a specific chemical reaction through the employment of the Arrhenius equation. In addition, relationships involving the distribution of molecular energies and the rate of the chemical reaction were studied with respect to activation energy and temperature. This equation shows how a temperature increase causes its reaction rate to increase, also. The chemical reaction studied involved the color change associated with the heating of crab shells, caused by the decomposition of the pigment, composed of caroteno-proteins within the shell. Results show an activation energy of 263 + 26.7 kJ. There may be reason to question the validity of the Arrhenius equation involving unimolecular reactions occuring at relatively low temperatures, due to an decrease in the ratio of activated molecules to nonactivated molecules.

#Fourth Award - General Motors ISEF/Chemistry

PENDULUM STUDIES III: CHEMICAL OSCILLATORS

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The effect of temperature change on the period of a chemical oscillator was studied in this project. Two oscillating reactions were used- variations of the Belousov-Zhabotinskii and the Briggs-Rauscher systems. The B-Z system uses sodium bromate, sodium bromide, malonic acid, sulfuric acid, and ferroin to produce reactions with color changes from red to blue and back to red in an oscillating manner. The B-R system uses potassium iodate, hydrogen peroxide, sulfuric acid, malonic acid, manganese sulfate, and starch to produce an oscillating reaction with color changes from colorless to yellow to blue.

Numerous periods were measured at various temperatures, and the average period for each temperature was calculated. A graph was prepared comparing period and temperature. The results showed that temperature does have an effect on the period of a chemical oscillator. As the temperature increases, the length of the period decreases.

BATHROOM CLEANERS: WHICH ONE REALLY DOES THE JOB?

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The purpose of this project was to determine which bathroom cleaner is the most effective in cleaning, the least abrasive, and which disinfects best.

My hypothesis was that the scientific method would allow me to determine which cleaner would be the best in each area and compare cleaners in each of the above areas.

A synthetic soap and hard water mixture was prepared and used to test the cleaning ability of each cleaner in removing the mixture from ceramic tile. Of the ten cleaners tested, Lime-A-Way was the most effective.

Controlled, repetitive scrubbing of soft glass plates revealed little or no abrasion caused by liquid cleaners, and almost no abrasion for Bon-Ami scouring powder.

Disinfectant tests were run on cultured mildew and mold samples taken from bathroom areas and cultured in standard culturing media. Measured amounts of cleaners were added to the cultures; before and after results were compared. Lime-A-Way, Bon-Ami, Tilex, and Tough Act destroyed more mildew than the other cleaners, although results were less definitive than desired.

My results agree well with other researchers, except where new products were tested and no comparisons existed.

#THE EFFECT OF VISCOSITY ON PYRENE EXCIMER FORMATION AND DISSOCIATION

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An excimer (a complex only stable in the excited state) is formed when once excited and one unexcited molecule of pyrene collide. Pyrene monomers and excimer fluoresce at different wavelengths and are thus easily identified. This project examined the effects of solvent viscosity on the formation and dissociation of pyrene excimers. The starting hypothesis was that the efficiency of excimer formation is inversely proportional to viscosity. Viscosity was measured with an Ostwald viscometer and fluorescence was measured with a Perkin-Elmer fluorimeter.

The viscosity results when temperature was varied followed closely the expected Arrhenius behavior. However, the viscosities of mixtures could be explained only by averaging the engergies of activation.

The fluorescecne measurements made at high solvent viscosity showed that the excimer-to-monomer intensity ratio is inversely proportional to viscosity, as predicted by the hypothesis. However, at low viscosity, the ratio became independent of viscosity. This observation required the introduction into the model of a new process: excimer dissociation. This means that an excimer, once formed, may fall apart again, yielding one excited and one ground state monomer. The efficiency of this process was assumed to be also inversely proportional to viscosity. Once the expanded model was worked into the hypothesis, all results could be explained.

#Third Award - General Motors ISEF/Chemistry

A STUDY OF THE EFFECT OF LIGHT ON LIESEGANG RING SYSTEMS

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The formation of Liesegang Rings occurs when a chemical salt diffuses into an aqueous medium containing another salt. The resulting precipitate forms in a pattern of rings. At this time, the phenomenon is not well understood, and no one is sure how the rings form. In this research, the formation of the Silver Chromate and Lead Chromate rings in different wavelengths of light and the presence or absence of light was studied. Each system was exposed to four different wavelengths of light, no light at all, and white light, and allowed to develop substantial specimens.

I conclude that light plays an important part in the Liesegang Ring systems. My studies have shown that the various wavelengths of light don't have any affect on the amount of precipitate formed, however the additional energy added to the system by the light does have a substantial effect. It may affect additional chemical reactions in the precipitate and the actual formation of rings. The Lead Chromate system only forms rings without the additional energy being added to the system by exposure to light. In the Silver Chromate system, there is an apparent formation of silver oxide or silver metal, after the initial formation of silver chromate. I propose to further study this effect which may prove valuable in the study of this phenomena.

#NOVEL DEVICE FOR DETERMINING THE MOLECULAR WEIGHTS OF GASES

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A series of gases, varying in molecular weights, were collected in a 100 cc syringe. The gases were allowed to flow from this syringe into a two liter vacuum flask. Three different needle sizes were investigated.

In conjuction with Graham's Law of Effusion, plots of the square of the flow time versus the molecular weights were prepared. This was done for each needle tested. From these three plots the optimum needle was chosen to test aerosol spray cans for chlorofluorocarbon propellants.

A gas collection system based on the displacement of water was designed and used to collect the propellants from each of the spray cans being tested. The flow times for all spray can propellants were measured and any result which yielded a molecular weight of greater than 80 was considered to be a CFC.

#First Award - Vacuum Technology Division of the American Vacuum Society
Third Award - General Motors ISEF/Chemistry

HYDROGEN PEROXIDE DECOMPOSITION KINETICS

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Hydrogen peroxide has been used for many years as a home and medical antiseptic as well as a laboratory oxidizer. The purpose of this experiment is to collect information about the kinetics of hydrogen peroxide decomposition in the presence of chemically stabilizing substances such as Na_2SnO_3 and $SnCl_4$. Commercial hydrogen peroxide solutions are stabilized by making them more acidic. In some cases this may not be practical or feasible.

The reaction rate of this decomposition reaction was measured by measuring the oxygen gas produced. The gas was collected under water and the volume determined at regular intervals using the graduations on a buret.

The pH was shifted to accelerate the reaction. A pH 12 buffer and a pH indicator solution maintained a stable monitor of pH. Various concentrations of the tested stabilizers were added to peroxide solutions and the evolution rate of oxygen gas was measured. These values were then compared to the reaction rate of hydrogen peroxide without any stabilizers.

The reaction rates were inversely proportional to the concentrations of the stabilizers. The close relationship between the two reaction rate graphs provides some support for the stabilization mechanism that was hypothesized. This also led to the prediction of another stabilizer which was found to have a similar stabilizing effect.

#MORPHOLOGICAL EFFECTS OF ANION IMPURITIES ON $NaClO_3$ AND ROCHELLE SALT

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Holden and Morrison, in their book "Crystals and Crystal Growing", state that it is possible to alter the morphology of $NaClO_3$ by the addition of borax (sodium borate, $Na_2B_4O_7$), but offer no explanation for this effect. Since only the $B_4O_7^{=}$ ion is foreign to the growth solution, it is possible that it alone is responsible for the morphological deviation. This supposition can be verified by the separate addition of sodium and borate ions from independent sources. It is also possible to determine whether other doubly charged anions can have similar effects. It is of interest to determine what effects ionic charge, pH impurity concentration, and the size of the impurity radical have on the morphology of the crystal.

A wide variety of singly, doubly, and triply charged anions were added during the growth of both the cubic sodium chlorate and orthorhombic Rochelle Salt. In several cases for each crystal, significant morphology changes occurred. These effects can be explained by preferential adsorption of the anions on different facets of the growing crystal. This explanation was supported by the verification of low impurity incorporation in the solid using atomic absorption spectroscopy, optical activity (for the sodium chlorate), X-ray diffraction, and X-ray fluorescence.

#First Award - General Motors ISEF/Chemistry
First Award - U.S. Air Force

OSCILLATING REACTIONS, II

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To further examine and study through a second-year experiment the phenomena that certain closed chemical systems visibly organize in spiral waves during oscillation. The experimenter will attempt to isolate such reactions and capture three-dimensional views.

Certain chemicals in a closed system where temperaure and pressure are held constant in a homegeneous mixture will result in oscillating reactions, as exemplified by definite and constant pattern of color change and organization of three-dimensional wave shapes that can be isolated and studied.

The reactants for the cerium-based oscillator include cerium ammonium nitrate, malonic acid, sulfuric acid, potassium bromate and ferroin. The net chemical reaction taking place in the system is the oxidation of malonic acid by bromate with a cerium ion catalyst. Three major examinations were made for spiral wave velocity, average band velocity compared to initial molar concentration, and three dimensional examination by utilizing stacks of Millipore Filters stained and cut in cross-section.

Band wave propagation produced a constant velocity of 2.8 mm/sec. Average velocity of band propagation vs. initial molar concentration for each of the reactants indicates cerium ammonium nitrate is the main reactant. Three-dimensional examination through Millipore Filters provides three main spiral wave shapes, with the U-Shaped Scroll Axis as the primary wave shape.

#Third Award - General Motors ISEF/Chemistry

EFFECTS OF SOLID SOLUTION ON UNIT CELL SIZE AND IONIC BOND LENGTHS

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This project is concerned with the study of the effects of solid solution on unit cell size and ionic bond length. The following assumption was made in this project: The molar ratio of the compounds stays the same before and after the precipitation and fusion procedures.

The chemical compounds studied in this research are KBr, KCI, and KI crystals. Samples of KBr-KCI and KBr-KI are mixed at different molar ratios. Three identical sets are made for each sample. The control set of this research project were not mixed by either precipitation or fusion. The other two sets were each mixed either by precipitation or by fusion. The graphs of the unit cell value of these sets will be compared to show the effects of ionic substitution on the unit cell size.

By the use of optical methods, refraction indexes of the samples were recorded, as well as the basic structure of the crystals. The crystals were found to be isometric. Data obtained by X-Ray diffraction reveals the crystal morphology of these compounds. The theory of this project includes two major conclusions:

(1) The unit cell size is larger in crystals that were produced by evaporation.
(2) The bond length is shorter in crystals produced by fusion.

ALALYSIS OF COLLIGATIVE PROPERTIES OF TANGERINE PEEL SOLUTION TO PREVENT FREEZING OF VEGETATION, A THIRD YEAR STUDY.

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PURPOSE: To find an economical and practical freeze protector. YEAR ONE: Tangerine peel solution protected tomato plant from freezing. YEAR TWO: Analyzed inorganic compounds in peel and found magnesium and potassium oxides protected plants. YEAR THREE: Colligative properties of organic and inorganic compounds found in tangerine peel were examined. 300 tomato, squash and pepper plants, grown from seed, were tested with .1, .5, 1, and 2 molar solutions of magnesium sulfate, potassium sulfate, potassium phosphate, glycerine, ethylene glycol, calcium oxide, thymol, tangerine peel solution, and water (standard). Plant sensitivity test were run first. Then timed freeze tests at a duration of 30 minutes in a domestic chest freezer in tests at -2°C., -3°C., and -4°C. were made. A glove bag was also used at the -2°C.,and -4°C. temps., During the nights of 2 predicted frosts and freezes, garden tomatoes, bell peppers, loofa, hybiscus, and zoysia grass were tested. Plant analysis was made and recorded at 1, 3, 7, and 14 day intervals. RESULTS: Colligative properties of 1 and 2 molar solutions of magnesium sulfate, potassium sulfate, potassium phosphate and ethylene glycol lowered the freezing point of the water and prevented freeze damage to the plants. Plants sprayed with these chemicals had dew-like droplets on leaves following the tests or on frosty mornings of outdoor freezes instead of ice crystals. All plants sprayed with .1 and .5 molar solutions died from freeze damage. Thymol, glycerine and calcium oxide did not protect plants from freeze damage. Tangerine peel solution plants survived and all standard plants died from freeze damage. Freezing point tests were also made on the solutions.
CONCLUSION: The colligative properties of compounds found in tangerine peel protected Florida vegetation from frost and freezing temperatures.

#INFLUENCE OF OXYGEN ON THE OXIDATION OF ASCORBIC ACID WHEN COMBINED WITH METAL IONS

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The purpose of my project is to test the rate of oxidation of ascorbic acid in an oxygen free environment and in an oxygen saturated one. Also, to test the oxidation when ascorbic acid is combined with metal ions. The results of the experiment will determine the effect on vitamin C containing foods such as cooked vegetables, pealed fruits, and canned fruits and vegetables that are not covered or vacuum sealed. My concern was that oxygen saturated solutions and the metal compounds would cause a decrease in the concentration of vitamin C.
My procedure included the testing of solutions in three different environments: oxygen (bubbler), carbon dioxide (bubbler) and a control environment. Each group contained four ascorbic acid-metal solutions and one ascorbic acid (control) solution. Each of the fifteen solutions was titrated during a four hour test period.
I observed that there is considerably more oxidation of ascorbic acid in an oxygen saturated environment when compared to an oxygen free environment. Ascorbic acid concentrations, in the oxygen free environment, remained relatively constant. The control environment solutions remained at a lower concentration level than those in the oxygen free environment. The metal compounds caused substantially more oxidation of ascorbic acid than was the case in the control solutions.
In conclusion, keeping vitamin C containing foods in an oxygen free environment, keeping a physical separator between metals and vitamin C containing foods and adding a chelating agent, such as EDTA will decrease concentration loss of ascorbic acid.

#Alternate to Scholarship - The Ohio State University

#SOYBEAN VARNISH

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PURPOSE: To determine if soybean oil and other natural oils can be used to make varnish and, if so, to compare the varnish(es) made with those purchased at the paint store.

PROCEDURE: Various natural oils were used in the experiments; each oil was first exposed to the air to see if any would form films. None except tung oil did. Second, Japan drier was added to each oil and all oils except olive oil formed tough wrinkly films. The same happened when each oil was heated for long periods at 500 degrees F. Next, the fatty acids of the oils (except tung) were separated from their triglycerides and reacted with multifunctional alcohols such as pentaerythritol and epoxy resins to form higher molecular weight esters. The oils with drier, the esters and some purchased varnishes were then applied to metal strips and tested for varnish hardness, flexibility, hydrochloric acid resistance, salt resistance, and soap resistance.

OBSERVATIONS AND CONCLUSIONS: (1) Soybean oil, like linseed and tung oil, can be used to make good varnishes. Olive oil will not form a film. Therefore, oils which have more than two double bonds per fatty acid molecule are needed to make varnish. (2) Some soybean oil epoxy resin esters make varnishes which are better than purchased varnishes. Molecular weights of 3000-6000 grams per mole were the best. This compares to molecular weights of about 885 grams per mole for the oils (triglycerides) and 1190 for the pentaerythritol esters.

#First Award - American Chemical Society
First Award - General Motors ISEF/Chemistry
Second Award - U.S. Air Force

BENEATH THE CLOUD: THE AFFECT OF NEUTRONS IN THE NUCLEUS

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This project is an intensive study into the effect of neutrons in the nucleus. By researching and observing situations where chemical variables may be measured, it is the intention of this project to determine if the chemical reactivity of an atom is affected by the number of neutrons in the nucleus.

Much of the background of atomic nature provides a vast array of knowledge and also raises many unanswered questions. Oddities in the correlation of atomic laws raise the issue that there is some unknown force within the atom not yet defined, which also plays a role in the physical and chemical properties that atoms possess. Of these "unknowns", the nature of isotopes raise some of the more complex questions. By using the factors presented by the different nuclei of similar atoms, reactions will be interpreted to correlate a relationship between neutron number and atomic properties, specifically electron behavior.

The two different isotopes in use, water and heavy water, have simple but a variety of reactions, which are similar to the reactions of most other chemicals. Because of heavy water's doubled mass of Hydrogen, any isotopic variance caused by the extra neutron within the Hydrogen atom will produce more calculable results. By measuring exo-thermic energy released by the two different isotopes in similar reactions, the strength of reactive forces between electrons during transference can be associated to atomic nature as determined by the make-up of the nucleus.

FURTHER STUDIES OF TRANSIENT RESPONSES IN GLASS ELECTRODES

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Glass Electrodes are subject to a phenomenon called transient response. My research has involved the study of these transient responses in various ways in order to learn more about them and help to eventually explain them, and it has consisted of 4 phases, of which the first two have been previously presented. In the first phase it was hypothesized that the transient responses were a result of the glass electrode itself and not interference from other parts of the experimental system. In phase two it was predicted that some relationship would be found between the concentration of the primary ion and the size of the transient responses. The hypothesis in phase three was that transient responses could be used to analyze multiple component systems, and in phase four the hypothesis was that there was a relationship between pH and transient response size. In all of these phases the basic method of investigation involved observing transient responses under various conditions and analyzing several of their characteristics. In phase one the hypothesis was proven correct, and in phase two it was found that there is an inverse relationship between the concentration of the primary ion and the size of the transient responses. In phase three the results indicated that the hypothesis was invalid, and in phase four it was found that there is a direct relationship between pH and transient response size. In general, this research has discovered many new facts concerning transient responses, and it has come one step closer to explaining this phenomenon.

# AN ANALYSIS OF ELECTRONIC TRANSITIONS IN SOME ORGANOMETALLOCENES

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This research has centered around Ultraviolet-Visible spectrophotometric analysis of the sandwich organometallocene ferrocene and selected derivatives. Ferrocene is the focal point in the field of cyclopentadienyl metal chemistry. The selected derivatives are acetylferrocene, 1-hydroxyethylferrocene, vinylferrocene, and benzylacetylferrocene.

The purpose of this research was two-pronged. At present, there are several different molecular orbital (MO) models for ferrocene. They have all been proposed to explain the electron configuration and intramolecular bonding of ferrocene. As such, the UV-Vis analysis of the electronic state of ferrocene was an attempt to determine which MO diagram was correct. At least, the research would indicate a diagram most in line with its findings.

Secondly, it was intended that the research isolate and characterize a theoretically predicted but never before "seen" metal to ligand absorbance peak. By utilizing a Hewlett-Packard 8451A Multi-Diode Array Spectrophotometer with interfaced microcomputer and plotter, the peak could be quantitatively measured. Moreover, the peaks in the spectra of the substituted species could be tracked, and, thus, aid in characterization of the theoretically predicted metal to ligand transition.

A peak of high absorbance (characteristic of a charge transfer peak) was isolated at lamda equal to approximately 238nm. By tracking the movement of this peak in the spectra of the substituted species, the theoretically predicted red shift was actually observed and measured. In addition, this red shift indicated that the observed peak must be of the metal to ligand electron transfer type (specifically a $^1E_{2g}$ to an E_{2u} transition). The MO diagram most in line with these findings was one proposed by Harry B. Gray of the California Institute of Technology.

#Third Award - General Motors ISEF/Chemistry

THE TRANSPORT OF POTASSIUM IONS ACROSS A LIQUID MEMBRANE BY DIBENZO-18-crown-6

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A liquid membrane barrier (chloroform, $CHCL_3$) was constructed as described in the manuscript between solutions of either the various potassium-halogen salts, or potassium ferricyanide, and distilled water. The chloroform layer contained a cation-carrier molecule (dibenzo-18-crown-6), which is able to complex alkali cations in its central cavity. The movement of potassium ions across the membrane was followed by flame emission photometry. The rate of transport of K^+ from $K_3Fe(CN)_6$ was found to be negligible compared to that of K^+ from KI and KBr solutions. The difference in rate is explained in terms of the nature of the cation-carrier complex and the charge and nature of the anion. The stability constant (rate constant) for this reaction compared to the ratio of the size of the cation to that of the carrier cavity will explain why potassium was the cation of choice.

#Honorable Mention - American Chemical Society

COMPUTER SCIENCE

MULTIPROCESSING ON A SMALL SCALE SYSTEM

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It has become widely accepted that multiprocessors are the path to very fast and powerful fifth-generation computers. Multiprocessing will likely be the foundation on which breakthroughs in artificial intelligence will depend. To make such technology widely available, such a machine must be reasonably small and inexpensive. However, multiprocessors currently available are large and expensive.

In this project, it is shown that the technology to build small, inexpensive multiprocessors is already available. In fact, a very small scale machine may be assembled from equipment in a relatively common home computer system. The implementation of two benchmark programs on this machine is described. Its performance is then compared with that of a serial home computer. Some problems of the small scale machine in its current form are discussed. A more practical architecture for the machine is then described.

#Second Award - IEEE Computer Society
Fourth Award - General Motors ISEF/Computer Science

REACTION TIME: AUDIAL vs. VISUAL STIMULI

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The purpose of this experiment was to design a computer program that is capable of determining the difference in reaction times to audial and visual stimuli and thus conclude which of the two is faster. The program developed for this purpose contains its own instructions and is totally self sufficient. It collects data by asking the test subject to react as quickly as possible to two different stimuli by pressing a key on the computer keyboard when the stimulus is given. The stimulus is in the form of a bell sound in the first phase of the test and in the form of a white square appearing in the middle of the screen in the second phase. Each phase of the test computes an average time from five trials and shows this average to the subject. After both phases are completed a graph relating the newly acquired times to a cumulative average computed by the program is shown. The results from data obtained from twenty high school students showed that reaction times to visual stimuli were approximately twice as long as those to audial stimuli.

The program was written in Applesoft BASIC on an Apple II+ personal computer. The actual timing routine was coded in 6502 Assembly Language due to its requirement for high speed execution.

#RECOGNITION OF GENERAL PATTERNS USING NEURAL NETWORKS

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Neural networks, parallel computer systems which are designed to mimic how the brain works, have been shown recently by Hopfield to possess pattern recognition skills similar to the human brain.

The Hopfield model of neural network effectively stores its memory in its symmetric synaptic connections but can only learn to recognize sets of nearly "orthogonal" patterns. A new algorithm is put forth to permit the recognition of general patterns. The algorithm specifies the construction of the new network's memory matrix **Tij**, which is, in general, asymmetrical and which contains the Hopfield neural network as a special case. There is a large degree of freedom in the construction of the memory matrices **Tij** which permit the recognition of general patterns.

A neural network following the new memory matrix was modeled on a computer and was successfully taught to recognize various sets of general patterns, including letters of the alphabet. The new network showed a high tolerance to altered, incomplete, and "fuzzy" data. The network also demonstrated a "robustness," i.e. the ability to function well even when individual processors fail. Further, this network has the advantage of speed from its parallel stucture. These advantages and the new neural network's ability to recognize general patterns without orthogonality restrictions may significantly extend the present and potential applications of the neural network, which include the recognition of aircraft, speech to text conversion, high speed sort/search routines, optical image processing systems, connections with rapid eye movement and psychological conditioning, similarities with spin glass systems, and use in unmanned space probes.

#First Award - U.S. Air Force
Second Award - General Motors ISEF/Computer Science

DEVELOPMENT OF AN ON LINE COMPUTER SYSTEM FOR LABORATORY DATA ACQUISITION AND ANALYSIS

Zamarripa, Robert, Harlingen H.S., Harlingen, Tx. 78550
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The purpose of this project is to develop an on line computer system for laboratory use so that a large number of accurate data can be collected and analyzed. This project aims at developing a procedure in which experiments can be completely performed with a computer. With this system, labs can be performed without having to record data or figure out calculations. The setup of an experiment in this system will be connected to a computer through a game port interface. An electrical device will then be used in the setup to detect a change in resistance, temperature, current, light intensity, or sound frequency. A computer in this system will perform all of the laboratory data collection, calculations, analysis of data, analysis of data with objectives, results, and further analysis of data. The experiments used to develop this system were the analysis of a simple pendulum and the determination of the molecular mass of a solute using a change in the boiling point of a solution. Appropriate software was developed to accept and analyze data from these experiments using a potentiometer and a thermistor. It was noted that this approach allowed for a large number of data points in a short period of time and a higher degree of precision. This data was saved on diskettes through sequential files and was later used to report results, present the data, and to perform a further analysis of the data.

A UNIVERSAL COMPUTER VISION EXPERT SYSTEM APPLIED TO UNIVALVE MOLLUSK IDENTIFICATION

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A computer vision expert system was designed to identify a universal set of objects based on a scanning procedure which analyzes digitized images. In addition to biological and inanimate objects, the system analyzes drawings and handwritten text, as well as kanji characters. The system's automation capacity can be directed towards identifying and sorting constant supplies of objects.

Univalve mollusks were selected to test the effectiveness of the program. The system first "learned" by individually scanning digitized binary shell images, calculating fifteen factors relating to length, width, perimeter, area, center of mass, and fuzzy perimeter factors of the shells, and storing the calculations according to genus in an array. After the system became sufficiently knowledgeable about the variation range of shell specimens within each genus, identification was attempted by processing digitized shell pictures and comparing their derived factors with the accumulated data.

Two subproblems--different identification algorithms and varying object orientation--were investigated. To determine the most effective identification algorithm, shell identification using (1) seven factor range method, (2) fifteen factor range method, and (3) small-space analysis were compared. Small-space analysis proved to be the most effective algorithm. Rotation experiments demonstrated that the system can identify objects varying in two-dimensional orientation most effectively by using the range method with seven factors. In all cases, the system was able to identify pictures that were previously processed 100% correctly. Inaccuracies in experimental results with related objects can be attributed to the limited sample size of shells preexposed to the computer during the learning stage.

*COMPUTER VISION AND OPTICAL RECOGNITION FOR ROBOTIC CONTROL

Worrall, Brian M., Terre Haute South Vigo H.S., Terre Haute, IN 47802
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During the next decade, man will be presented with many new and wonderful innovations in the field of computers, yet the most exciting of these is the advent of computer optics and recognition. With recent pressures on higher productivity and quality in global technology and world trends leaning toward computer integrated manufacturing, robot systems need sight for part selection, welding, and precision tasks.

This research is the final phase of a four-year investigation into the sensory applications of microcomputers, covering such areas as software music and speech synthesis (1983), hardware speech synthesis and artificial intelligence (1984), and digital speech recognition with robot interfacing (1985). Based on this background, the final phase concerns the development of a multipurpose sensing system, entitled DEXICON, for the TRS-80 Color Computer. This interactive system allows a computer to visually scan a work matrix, locate objects, and then identify them. Furthermore, by using information provided by the imaging system, the computer will access and control a servomechanical unit to retrieve and manipulate those objects. The finished operating system is to communicate with the user via speech synthesis and voice recognition, thus covering a wide variety of machine senses.

The system consists of three segments: A computer imaging system utilizing the IS32 OpticRAM from Micron Technology, a pattern/object recognition algorithm yielding normalized shape templates and other object information, and a robot control system using an adapted Radio Shack ARMITRON unit and a complex motion equation based on homogeneous link transformations and matrices in three-space. Results thus far have been good considering the precision of the equipment, with recognition running at 90% and complete object manipulation 80% of the time.

*First Award - General Motors Corporation
Second Award - Society of Manufacturing Engineers
Fourth Award - General Motors ISEF/Computer Science
Honorable Mention - Optical Society of America

*COGITO ERGO SUM - NATURAL LANGUAGE PROCESSING

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An Artificial Intelligence natural language processor, or parser, is a program that analyzes sentences. A parser must be able to handle three general problems: (1) multiple sentences, (2) inferred ideas, and (3) semantic ambiguity, the most serious problem.

This original natural language processor is an intelligent problem solver based on expandable context expectation and connectionistic analysis. It is a synthesis of syntax based parser, a clause parser, and neuro parser. There are three aspects of my program, "RODIN," which implement this paradigm: (1) a **unique context-based system,** which is a combination of the syntactic parser, the conceptual parser, and the connectionistic parser. It selects hypotheses based on evidence in the lexicon and the knowledge base, (2) **a conceptual and structural support for expansion in the lexicon** based on the syntactic model, (3) **a connectionistic system in the knowledge base** that aids in parsing by expectation and allows parallel parsing. This original parser effectively demonstrates intelligent manipulation of ambiguity, multiple sentences, and the organization of plans and goals by using the Blocks World model.

*Third Award - IEEE Computer Society
Honorable Mention - National Aeronautics and Space Administration

#GRAVITATION

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The intent of this project is to determine if it is possible to create a computer simulation that will display the gravitational actions of objects in a vacuum. Data needed for this simulation are the initial positions, initial velocities, and masses of a number of objects. With these data, a "universe" is set up, and motion of the stars, planets, asteroids, golf balls, BB's, or whatever is in the simulation, gets underway. The method used to calculate motion is numerical integration. This allows each of the objects to move in discrete "steps." Since in the real world there are no "steps", but rather smooth motion, numerical integration is imperfect. It may get extremely close to exactness, but can never reach it. The closer to exactness, the longer the calculations take. An absolutely exact simulation is impossible, but motions can be represented with sufficient accuracy. Thus, these simulations are able to be used to determine the motion of stars over long periods of time and paths of planets in orbits near stars.

#Second Award - American Astronautical Society

FORMAL LOGIC AND NATURAL LANGUAGE

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One of the foremost problems facing computers while processing natural language is the existence of ambiguous statements. Usually people do not find these difficult to deal with - yet computers can be easily overwhelmed by ambiguity. We would like to permit automata to understand sentences that consist of more than simple noun-verb phrase combinations. This involves providing them with some method of understanding the meaning of a sentence.

My initial research involved determining a way to teach a computer the definitions of words and the relationships that exist between them. This has been accomplished. I then found methods through which a language processor can reduce a natural language into a context-grammar. By knowing such basic constituents of language, a language processor can draw more complex conclusions about a passage and approach some level of human understanding.

By using these methods, I have been able to give a computer the ability to successfully deal with some well-known examples of ambiguous statements. This was possible, for with the addition of context, a machine can use more "intelligent" reasoning. Also, because natural language is intended for human beings, the best method to enable a computer to read seems to be by having it imitate human methods.

#First Award - Upsilon Pi Epsilon, The National Computer Science Honor Society
Third Award - General Motors ISEF/Computer Science
Honorable Mention - American Speech-Language-Hearing Association

#ARTIFICIAL INTELLIGENCE IN COMPUTER CHECKERS

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My project attempts to imitate the human thinking process in a simple game of checkers on the computer by applying the five elements of an artificially intelligent program:

1. The Interface Component
2. The Knowledge Acquisition Component
3. The Knowledge Base Component
4. The Explanation Component
5. The Problem Solving/Inference Component

I then verified that my program was indeed learning in two ways:

1. I had several high school students play checkers with a computer opponent and then plotted the average number of pieces remaining.
2. I had several elementary school students round robin with each other, train a computer to their style for 10 games, and then played the computers in a round tournament.

The results of both of these methods of verification adequately proved my project was learning.

#Fourth Award - General Motors ISEF/Computer Science

# AN OBJECT-ORIENTED APPROACH TO PARALLEL PROCESSING

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One of the greatest driving forces in the computer industry has been the unquenchable thirst for greater processing power. The most feasible means of satisfying this thirst is parallel processing in which multiple processors work in parallel to solve a common problem. While parallel processing offers great power, this power has been uncontrollable due to the complexity of coordinating multiple processors. Object-oriented programming offers one possible means of controlling this power. The purpose of this project was to find a way to harness the power of parallel processing by using object-oriented programming.

It was first necessary to choose from the available parallel processing architectures that architecture which would most feasibly support object-oriented programming. The hyper-cube architecture, in which each processor has private memory and links to neighboring processors, was chosen. The transputer, a hyper-cube microprocessor, was chosen as the host processor for research because it provided both a low cost, under $500 per processor, and a commercially available base for development.

Once a hardware base was provided, it was necessary to create a object locating algorithm which would work within the hyper-cube architecture. To facilitate development of the algorithm, a virtual machine was created which would allow easy debugging and testing within a controlled environment. Next, several different object locating algorithms were designed and tested. The most successful algorithm, called PDM for processor direction method, refers to objects using a object pointer, for locating the object within the processor's memory, and an object direction block which directs the system software to the processor on which the object actually resides. Objects communicate by passing messages between processors through the use of PDM and new objects are created using a dynamic load balancing algorithm.

PDM provides a powerful and efficient approach to implementing object-oriented programming on a hyper-cube parallel processing architecture. PDM has many possible usages including distributed processing in both local- and wide-area networks. The area in which PDM will be most advantageous is in the construction of low cost parallel processing super-computers.

#First Award - U.S. Navy
Fourth Award - General Motors ISEF/Computer Science
Alternate to London International Youth Science Fortnight Trip - U.S. Marine Corps

#THE PSYCHOLOGICAL SYSTEM: A COMPUTERIZED EXPERT SYSTEM

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Microcomputers are rapidly becoming more prevalent in many fields including psychology. This project has evolved from four years of research and demonstrates how the microcomputer can be used in personality assessment and biofeedback/stress management.

The psychoanalysis module of the project features a full, grammatically correct English text (1-2 pages) derived from four personality models. These include Meyers-Briggs, Maslow's hierarchy of needs, transactional analysis, and neurolinguistic programming. These approaches to personality were integrated to assist in validating elements of a theory proposed by this researcher. The program features the ability to analyze how two specific people may interact as well as revealing individual personality traits.

With regard to biofeedback, most available units provide only immediate feedback and are incapable of saving data and viewing it at a later time for analysis. While the visual feedback modes of some units have become quite sophisticated, auditory feedback has remained limited to simple tones or chords.

This computer driven biofeedback module includes a galvanic skin resistance sensor and graphic software capable of recording, plotting, and recalling saved data. Unlike other units, the system also utilizes speech synthesized sound capable of providing varied verbal feedback similar to a live therapist. The latter feature is a prototype which will serve as a means of further assessing therapist effects in relaxation training.

#Third Award - General Motors ISEF/Computer Science

Building A Knowledge Base System With A Natural Language Interface

Dion Hinchcliffe
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6121 Empire Circle, Las Vegas, NV 89107

In this project, a study of expert systems and knowledge bases was conducted and an advanced knowledge base system (a complex relational database) was programmed on a specially designed computer system. The program was written in an advanced programming language called Prolog, which is designed for such projects. The program, entitled NLBASE, accepts an input file of facts and the relationships among those facts, providing it with an environment in which to "learn" and "understand". The user then makes queries within the domain of the database using natural language to extract knowledge from the system. The program is "artificially intelligent" to the extent that it can draw conclusions from and perform calculations upon the knowledge that it has stored in the computer's memory. Any kind of information can be given to the program so long as the relations between the facts are adequately defined to the program. Programs such as this are very powerful at performing data computation, breakdown, and analysis. This has rarely been implemented successfully on a microcomputer system, due to the complexity of the task. This experiment succeeded quite well, profiting to a great extent from newly developed techniques in computational linguistics and contextual analysis.

#Honorable Mention - Upsilon Pi Epsilon, The National Computer Science Honor Society

#COMPUTATIONAL COMPLEXITY AND RECONFIGURABLE ARCHITECTURE UNDER SOFTWARE CONTROL

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My investigation deals with the technical issues associated with algorithms and architectures. For this purpose, I constructed four identical processors to work in conjunction with my Apple II+ personal computer. I also developed software for determining the relationship between: (1) different types of computational problems frequently encountered in scientific and engineering applications; (2) different models (sequential, parallel) of computation; (3) different measures (time, memory space requirements) of computational complexity; and (4) different programming languages (BASIC, C, Pascal) used for computation. The types of problems considered may be stated, in general, as follows: (1) addition of n integers; (2) sorting and searching n integers; (3) addition of vectors with n components; (4) addition of nxn matrices; (5) multiplication of nxn matrices; (6) inversion of nxn matrices; (7) evaluation of polynomials of degree n; and (8) solution of nxn simultaneous equations. The computational complexity attributed to the type of problem, and the computational load of each type of problem, defined by the parameter n, have been determined. For achieving the best match between algorithm and architecture and improving throughput, the architecture is reconfigured under software control. A system of parameters (speed-up factor, efficiency of hardware configuration, and effectiveness of the hardware-software system) related to each problem has been evaluated for trade-off studies in the design of parallel processing computers. The variation of these parameters with respect to the number of processors utilized has also been obtained.

#First Award - Association for Computing Machinery
First Award - National Aeronautics and Space Administration
First Award - U.S. Army
Second Award - U.S. Air Force
Third Award - General Motors ISEF/Computer Science
Summer Math Scholarship - The Ohio State University
Alternate to Operation Cherry Blossom Trip - U.S. Army
Alternate to Four Year Scholarship - The Ohio State University

COMPUTER REGISTRATION PROCESSING FOR SCJAS WORKSHOPS

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The South Carolina Junior Academy of Science sponsors a program of workshops, twice annually, which are attended by students and teachers from throughout the state. The number of people participating in these workshops has in recent years become so high that processing pre-registration forms by hand is tedious and often unfair and that the demand for certain workshops is sometimes far greater than the workshops' capacities. A way to schedule pre-registered students quickly and randomly for the February 7, 1987 winter workshops at the University of South Carolina at Spartanburg was needed. SCJAS Registration Master, a system of three interacting programs which create and manipulate six data files, was devised on a 64K TRS-80 Model 4 Microcomputer under TRSDOS 6.2 and Microsoft Basic. SCJAS Registration Master quickly and efficiently produced schedules for the 441 pre-registered students at the 1987 winter workshops. This menu-driven self-documenting system can easily be used to process pre-registration at all futrue SCJAS workshops.

# USLAI: A UNIVERSAL SYMBOLIC LANGUAGE FOR ARTIFICIAL INTELLIGENCE

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This project explores some computer applications of my invention, Phonetic Semantography (PS). Integration of the symbolic, graphic, numeric, and phonetic interpretations of a data system may greatly enhance the performance of computers in artificial intelligence contexts. The automatic datalinking properties of USLAI are demonstrated through simple examples of sorting and searching. A brief USLAI data table (less than 100K bytes long) and an off-the-shelf search program allow full language capability for machine recognition of meanings. This "intelligent paraphrasing" function could become an important component of machine translation systems.

#Honorable Mention - American Speech-Language-Hearing Association

Fortress

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Fortress is a computer game for two players. Each player is the ruler of a might fortress. There is an army of 1,000 knights to help protect either fortress during battle. Four catapults are aligned at the castle walls of each player's fortress. One player has a fire-breathing dragon as the guardian of his fortress, along with two spies to sneak up on the knights of the other player. The other player owns a powerful giant used to wipe out knights, destroy catapults, bash in the opposite fortress, and ambush the dragon. The object of the game is to destroy the other player's fortress (There is only one best way to do that).

COMPUTERIZED PETS

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The purpose of this prototype system, P.A.C.S. (Programmable Automated Computer System) was to determine the connection between computers and robotics by investigating the possibilities of interfacing a robot with a home computer. The capabilities of this system will also be determined. The software used was homemade in BASIC.

The amazing "missing link" between computers and robotics is called "Simulation." Creating robots without parts, points directly to simulation. After approximately three months of BASIC programming, a small moving block that bounced off walls (similar to a "bump and go" toy that occasionally "ate" the furniture) was produced.

The challenge was building the rolling robotic interface. Building and modifying "Beta" took almost two months. The robot that resulted can touch, with contact switches, and see, using a photocell, then responding to these senses by learning to avoid objects with a type of timing method.

The last modification on "Beta" was a remote "radio" controlled 27 mhz link between the computer and robot. Due to the digital nature of the radio control, the degree of accuracy was lost in the analog vision system for autonomy.

The remote control modules, relays and L.E.D.'s were purchased at a local Radio Shack store, the hardware was obtained by scrounging and surplus stores.

A NEW ALGORITHM FOR THE TRAVELING SALESMAN PROBLEM

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The classical 2-D Traveling Salesman problem requires finding the shortest closed path connecting certain destinations. The 3-D Traveling Salesman problem is the same except that altitude variations are allowed.

The N-destination problem has (N-1)! possible paths. It takes days for super computers to exhaustively search for the exact solution for even an N=20 problem. Fast approximate methods are available, but they all depend on principles that hold only for 2-D cases (i.e., uncrossing lines). I hypothesized that to find a 3-D solution a new approach would have to be used.

My goal was to find a fast, approximate solution to the 3-D Traveling Salesman problem. This is a practical goal because in many situations quickly finding a good path is better than slowly finding a perfect path.

Using geometric analysis I found three principles that could be used to form a new algorithm for 3-D problems. With my new algorithm, the 48 state, 3-D traveling salesman problem is solved in 6 seconds. When the number of destinations is under 150 (my computer's memory limitation) the algorithm operates in polynomial time with an exponent of 2.

To check my results (for a small N) I used an exhaustive search program. In every case my method gave the exact solution. Additionally, I showed that as the altitude variable was reduced the 3-D solutions approached known 2-D solutions. The run time of my program beats anything I have found in the library for 2-D problems.

#First Award - General Motors Corporation
Second Award - Federal Aviation Administration
Alternate to Scholarship - The Ohio State University

SYMBOL RECOGNITION BY COMPUTERS

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Many experts contend that the world stands at the threshold of a "computer revolution." Advances in circuit design and computer programming have already had tremendous impacts on society. But no real "revolution" can occur until computers are able to freely interact with their users, communicating on human terms. Even today's most advanced computers, for example, cannot approach the accuracy and efficiency with which a human being can read symbols and characters. Scientists only vaguely understand the process by which humans perceive and interpret writing. If we could teach a computer to read, we would enhance data processing skills, establish fundamental rules for computer vision, create new educational roles for computers, and even gain profound insight into the workings of the human brain.

The original version of this project was extremely slow and produced mixed results. But, as I struggled with the task of teaching a computer to perform a process I daily take for granted, speed and accuracy both began to improve. The program now has the ability to recognize a letter of the alphabet, or any other symbol it is taught. By constantly refining the program's central algorithm, I have drawn continually closer to the goal of mimicking a human's ability to read.

COMPUTER-BASED ECOLOGICAL SIMULATION

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Purpose: To simulate, on a computer, relationships between sharks and fish; also evolution of simple organisms.
Hypothesis: It is possible to create a computer program which will simulate the interactions of sharks and fish in an ocean showing population curves of actual predator-prey relationships.
Procedure: I created two programs, WATOR and LIFE based on descriptions in the "computer recreations" column of the December'84 & November'85 issues of Scientific American to test my hypothesis. I then ran each program several times, changing variables each time so as to get a variety of data. For WATOR, I compared my graphs with the theoretical "target" graph to see which fit most closely. For LIFE,I compared data to see which combinations of variables yielded a 100% predictor after the fewest chronons. (Time unit for WATOR)
Program Descriptions: WATOR as described by A.K.Dewdney in Dec'84 issue of Scientific American is a program which simulates the interactions of shark and fish populations on the hypothetical ocean-planet of WATOR. LIFE was inspired by a book that appeared in the early 1960's titled "Artificial Intelligence Through Simulated Evolution". "Flibs" (finite living blobs) are fed a string of digits, and they are scored on how well they predict the next character they are fed.
Results: After running WATOR under several different conditions, the results closely match my target graph. Upon comparing several runs of LIFE, under certain conditions , perfect predictors evolve much faster.
Conclusion: It is possible to simulate both the relationship between predator and prey, and the evolution of a simple organism on a computer.
Applications: After more development, programs such as these may be applied to many areas. WATOR will probably be used for wildlife studies.

#SPEECH COMPRESSION USING THE OREDERD HADAMARD TRANSFORM

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1987 CRESCENT, LAS CRUCES, N.M. 88005

A series of experiments were run to find out whether or not the ordered Hadamard transform possesses properties that can prove useful in speech signal processing. It is believed that transforms process information in all living animals. In the brains of bats, dolphins, and macaque monkeys, transform-like structures have been discovered in the nerves of their ears. These transforms may very well get rid of most of the unimportant information and save the most important information. Can the ordered Hadamard transform separate the essential information form the nonessential information? The hypothesis is that the ordered Hadamard transfrom can be used to separate of filter out the unimportant carriers from the important information, specifically to extract information from human speech. In the summer of 1985, I built a computer to digitize speech. It has two analog to digital ports and two digital to analog ports. The microprocessor is a 6809 and it has 56k bytes of RAM. This year I built a set of four amplifiers to connect to the computer. The digitized speech is stored in arrays needed for the transform process. My hypothesis was proven correct by averaging every pair of elements together in the sequence domain. This resulted in a two to one compression ratio. The speech doubled in speed, but the frequency of the carriers did not change. Speech recognition could be used for artificial intelligence or for a voice activated typewriter for the handicapped.

#Fourth Award - General Motors ISEF/Computer Science

#ARTIFICIAL INTELLIGENCE: A COMPUTER LEARNS MATH THROUGH ENGLISH

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My project is a computer program which is taught mathematics by the user. The user describes a new concept using English sentences typed on the keyboard, and the computer translates and remembers the definition. This new concept can then be used to build up even more knowledge. The computer can answer many different questions about what it has been taught. All communication takes place in English, so the user does not need any programming experience.

The program which I wrote to do all this is fifteen pages of standard Microsoft BASIC. I wrote it on a Commodore 64 computer, but it can be translated to run on other computer systems. The program has many applications, including use as an example of artificial intelligence, as a learning calculator, or as a math tutor. The program consists mainly of subroutines, many of which can be taken out and used in other programs. The parser could be used as the basis for an adventure game.

When the program was first run, it knew only some fundamental English words, how to move up and down on a number line, and how to determine the smaller of two numbers. From that basic knowledge, it has learned many different words, including functions such as "plus" and "raise to the power" and adjectives such as "equal to" and "positive." There are still more things which it can learn, and it can be very interesting to see the intelligence displayed by even a small computer.

#Honorable Mention - Association for Computing Machinery

KAT - A NEW LANGUAGE - COMPUTERS V

Page, Kathryn E., Bloomfield H.S., Bloomfield, NM 87413
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The first edition of KAT could not be changed or corrected which made it too inflexable to be of much value to programmers. A syntax was also needed in order for programmers to know the proper structure of KAT. A computer languages' power is directly related to it's flexibiligy. Could primitives and syntax be created to make KAT more flexable?

The purpose of this year's project was to expand KAT so that it has syntax, a line editor, pen color, a delete procedure, and a repeat loop procedure. The structuring of Save and Retrieve procedures needed to be changed to make them more powerful. Further research was done into computer language construction. Tests were performed to determine how to manipulate programs into becoming KAT primitives. Many experiments were necessary in order to create these primitives.

As a result, KAT, in its embrionic stage has been expanded by using Pascal as an interpreter language. KAT become more user friendly and complex by adding these primitives.

For example, to draw a line, make a mistake, correct the mistake, redraw the line, and save to disk, Pascal takes thirteen steps, Logo takes eleven steps, and KAT only takes five steps. KAT has a savings of better than 50%.

Just as human languages have evolved to fit the needs of particular groups of people, so have computer languages been tailored to different functions. A useful language needs [illegible] be capable of precision and productivity never dreamed of befo[illegible] It is hoped KAT will become such a language.

#A Study of Depth Perception in Computer Graphics

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The purpose of this project is to circumvent the limitations of a two dimensional computer monitor screen and give depth to computer graphics. This is accomplished by adding binocular vision, a major depth cue, which normally lacks in computer graphics.

While looking through my system of four mirrors designed to divide vision between eyes, an observer can focus on the center of the computer monitor as each of his eyes is actually seeing a separate half of the screen. Since the observer's vision is divided, the computer can produce two different images: one for each eye. The same three dimensional projection is drawn on each side of the screen, but calculated at different angles so that each eye sees its own respective view as it would if it were seeing a real three-dimensional scene.

By using an IBM PC, a Tecmar Graphics Master display adaptor, an experimentally designed double reflecting mirror stereoscope, and a self written collection of machine language graphics primitives which can be used while programming in Borland's Turbo Pascal, this project adds visual depth to a computer monitor in excess of twenty distinguishable depth planes.

#First Award - General Motors ISEF/Computer Science
Honorable Mention - Upsilon Pi Epsilon, The National Computer Science Honor Society

ENGLISH INTO URDU

HUMAYUN CHAUDHRY
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The main purpose of this project is to phonetically transcribe English words into Urdu script using an Apple II computer. The program to accomplish this takes as input English letters and using the rules of phonetics produces graphics for the corresponding Urdu script. This program can be used by persons not familiar with the Urdu alphabet to produce Urdu script. Urdu words are pronounced to the computer operator and he/she types in the English spelling for the sounds heard. The program then displays on the screen the Urdu script for this word. Since proper names are pronounced the same in both languages, the computer operator can enter the English spelling of the name and the program will produce Urdu script for the name. This program is usefull to persons working in English/Urdu bilingual settings, such as the officies of immigration or international trade or persons involved in international relations.

The second purpose of this project is to convert an Apple II computer into an Urdu/Arabic scriptwriter. To accomplish this, an overlay for the keyboard was made which changed the English keyboard into an Urdu/Arabic keyboard. The program produces the appropriate Urdu/Arabic script in graphics. This program can be used to produce document in Urdu/Arabic languages.

E-Z DRAW GRAPHICS UTILITY

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The number of problems investigated was colossal. A few were: training pilots without risk, designing machines, buildings, etc., how to plot sub-atomic particles, simulate events, and designing graphics and art for T.V. This project proves how these and many more may be solved. The hypothetical solution was computer graphics. I wrote programs for the TRS-80 and Apple IIC, and created EZ DRAW, making improvements for over a year. It enables anyone to draw anything, save, copy, and/or change it. The main function is educating people about how computer graphics work to make their lives safer and more fun. These programs are the original work of Gabe Williams.

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16 BIT CYCLIC REDUNDANCY CHECKING: ARE THEY SUFFICIENT?

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The purpose of this experiment was to explore the thoroughness and effectiveness of the current standard error checking protocol (16 bit CRC.) From here, I must divide the project into two basic parts: (A) To thoroughly test the current error checking method and analyze it. (B) If it is found to be ineffective and inefficient, it would be necessary to explore alternative methods that would not be prone to the weaknesses found in the 16 bit CRC protocol.

If a need for an alternative protocol is found, some basic points must be addressed: (A) Do the improvements in the error checking protocol justify a change in the standard from the current status quo? (B) If so, is it significantly more "processor intensive" that opens up the possibility that it might alienate the current generation of 16 bit computers.

#CELLULAR AUTOMATION DATA ENCRIPTION

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The Cellular Automation Data Encryption project (CADE) involved designing a new method of encoding information specifically for use with microcomputers. The algorithm (method) was created after studying some of the principals of cryptography. Upon completion, the algorithm was successfully implemented on an Apple //e microcomputer. The algorithm uses cellular automation as a chaotic randomizer and thus achieves a high degree of security. The end product results in encoded information which is impractical to decrypt without knowing the encryption process. CADE has the ability to protect all digital information and may be used wherever data security and information integrity are required such as electronic banking, telecommunications, and satelite transmissions, etc. In the information age, CADE has unlimited applications because of our growing dependence on computers and the information they possess.

#Third Award - General Motors ISEF/Computer Science

A DIAL-UP TELEPHONE D.A.D. COMPUTER PACKET NETWORK

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In the computer industry today, there is constant competition between manufacturers to come up with a unique product. Unfortunately this means that since these computers are unique, they cannot share programs or data. Therefore the end-user (the buyer) must be responsible for the use of his other computer with computers he may already have.

To try to bring computers and their users together, computer networks have been formed. A computer network is many computers hooked together, usually by telephone, to allow for the proliferation of programs and information throughout all these computers. One obstacle to hooking a computer into one of these computer networks is that an interface, or program written specifically to hook the computer into the network, is required.

This arrangement of computers hooked together through telephones is what this science fair project is based on. The purpose of the project is to write a program. The program, named SLICK, is an actual WORKING interface (or way of connecting) to FIDONET, a worldwide computer network for the Hewlett-Packard Touchscreen series of computers. This program allows for the integration of the Touchscreen into FIDONET. This has never been offered before.

#OPTICAL SCANNING

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Optical scanning is the process of translating visual images into usable data. The computer industry has found many ways to use the process. Character recognition, the process of scanning letters, can be used in place of a typist. A scanner can read pages of text in a fraction of the time it would take a typist to enter it in. When reading characters is not the job, optical scanning can be used to take any image and place it on the computer screen. This is sometimes called digitizing. The many computers can make great use of scanned images. In business scanning can be used for presentations, graphs, maps, and to transmit pictures over phone lines.

My project centers on building and finding uses for an inexpensive scanner. With relatively inexpensive equipment, I have constructed an optical scanner. It can reproduce pictures on the computer screen rather accurately. Hopefully my project will show that everyone can use optical scanning.

#Honorable Mention - National Aeronautics and Space Administration

COMPUTER CONTROLLED ROBOTICS

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When the mechanics of hooking up a radio controlled robot to the computer are out of the way, there arise some special problems. For example, how accurately can the computer control it?

Consider this hypothetical situation: an industry needs a mobile robot to perform a task which must be repeated several times accurately. The robot must go to a conveyor belt, pick up a box, and transport the box to a storage location.

Can this simple robot (henceforth dubbed J.R.*) do this? Yes, and no. In my programming effort, I achieved near accuracy using the computer's built in timer, but problems such as an inconsistent power supply and friction loss still plagued preciseness.

Now consider this: J.R. will be working with other robots and will need to know when one blocks his path. Necessity is the mother of invention, so I used remnants of a second remote control car to send feedback. A new question presented itself: can the computer plot a course around an obstacle and then resume its task? For this problem I experimented with trying to keep track of orientation and found it basically predictable. The remaining challenge was to estimate J,R,'s displacement from his task, which I did.

One more hypothetical: the robot must be told when the storage area is full. If, upon setting down tHe last box, a light signalled the robot, it would continue its assignment, storing its cargo in a new area.

J.R, does this well. With a photoresistor mounted on the front of him, a light sends a signal back to the computer, telling the program the storage is full.

* Since the robot is basically spare parts, J.R. = Junk Robot

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THE DESIGN AND IMPLEMENTATION OF A LOW COST, HIGH PERFORMANCE IMAGE PROCESSING WORKSTATION

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The purpose of this project was to design and implement a digital image processing workstation on a commercially available personal microcomputer. This workstation must have features which are available on commercial systems and must also be easy to operate for a variety of users.

This goal was achieved by using the Amiga 1000 personal microcomputer. Algorithms were designed and written to perform many image processing and graphics functions. I taught myself Modula-2 to write the software system.

This small, powerful workstation could be an extremely useful tool for any imaging application such as a small research lab, hospitals, or even some schools. Potential applications of this low-cost system range from astronomy, geology and earth resource analysis, military intelligence, medical imaging, object recognition, infrared imaging, mapping, materials testing, and even manufacturing and quality control of goods.

#First Award - Ball Corporation
First Award - IEEE Computer Society
Third Award - American Intellectual Property Law Association

#COMPUTER CONTROLLED ENVIRONMENTAL CHAMBER

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The computer controlled environmental control system is a prototype system designed and developed to provide a controlled environment for plant life. The system monitors temperature, humidity, light level, soil moisture, and one auxiliary input and controls these variables using four outputs which control a lighting system, a heating system, airflow system, and a water and nutrient pump.

The input circuits use the game paddle potentiometer input to measure temperature and light level. The measurement of soil moisture and humidity is accomplished by a balanced charge astable oscillator which prevents DC current from causing electrolysis in the sensing elements. The soil moisture and humidity sensing elements' resistance is converted to frequency by the oscillators and are counted by the computer. The output circuits consist of optically coupled triac drivers driven by the game port digital outputs and control power to four AC outlets.

The system has been proven to provide a stable environment over a wide range of set point conditions and should prove to be useful in large scale applications such as greenhouses, hydroponic applications, automatic irrigation systems for agriculture, as well as for laboratory use.

#First Award - Federal Aviation Administration
Second Award - Sigma Xi, The Scientific Research Society

CAN COMPUTERS COMPOSE AESTHETIC MUSIC WITH APPLIED COUNTERPOINT?

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The purpose of this research is to determine if a computer system utilizing rules of applied counterpoint can be programmed to compose aesthetic music. The hypothesis is that such a computer system can be developed. The experimental procedure has four phases. In Phase I, the experimenter selected and acquired the necessary equipment after gathering information on music theory and related composition experiments. In Phase II, musical rules to be implemented were decided upon and expressed in logic. After orientation with the system, the researcher wrote "pre-composition" software. In Phase III, composition subroutines were written in FORTRAN which chose and tested random chords for aesthetic qualities. Acceptable chords were arranged in a four-voice, quarter-note harmony. In Phase IV, compositions are being refined to be more aesthetic with the addition of varied rhythm, pre-conceived chord progressions, cadences, seventh chords, and modulation. Experimental results consist of twenty tunes, composed with various musical rules. Qualitative analysis suggests that the music is generally consonant. During the completion of Phase IV, professional evaluations are being used to draw aesthetic conclusions. The experimenter's conclusion is that a system capable of composing consonant and generally aesthetic music has been developed. Further research is necessary to determine the aesthetics, efficiency, and effectiveness of this method of computer musical composition.

#THE DESIGN OF A OPTIMIZED MULTIPROCESSING SYSTEM

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Multiprocessing is defined as the use of multiple processors running concurrently to solve a single problem. The purpose of this project is to design and construct a low cost parallel processing system using current high performance 32-bit processors and coprocessors. The processor selected for use in this project was the Motorola 68000 paired with a 68881 Floating Point Coprocessor. This will allow the computer to operate concurrently on both the node and the coprocessor level.

When completed the system will be able to execute a variety of simulation or application programs thereby providing the user with a large degree of flexibility. At this time two different node boards have been constructed. Both node boards have the capability of moving information between microprocessors, and make use of the customized instruction capability of the 68000. The final node design uses high speed PROMs for decoding, tri-ported memory, and a more efficient node arrangement. Although the second nodes peak processing speed will not be much greater than the first, there will be performance gains due to increased efficiency and reduced software overhead.

In conclusion, a low-cost, high performance parallel processing system has been designed, constructed, and is currently being made operational.

#Third Award - General Motors ISEF/Computer Science
Alternate to London International Youth Science Fortnight
Trip - U.S. Navy/NORDA

0220 : TEACHING COMPUTERS TO READ

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The purpose of this project was to design a "language" that a computer could understand; that is, a method of translating meaning, rather than characters, into binary code. The project itself is a preliminary version of the language, called 0220 (the language). This version has a vocabulary of approximately 500 words, and can translate most kinds of simple sentence structure. 0220 stores sentence data by placing a 3-byte "skeleton" before each sentence, which outlines that sentence's grammatical structure. Various applications of the system are also illustrated. One of these is a program that takes data in the binary language and "detranslates" it into Spanish. This part will show that the computer can actually understand the meaning and grammar of the text. The applications of this system and systems like it are clear and many. Once a detranslator program is written for a language, any text stored in 0220 can be immediately sent out in that language. 0220 also uses approximately one third the memory space taken up by English text. This attribute makes it ideal for mass storage, especially for technical material in which the nuances of expression are unimportant. 0220 text, because of its lack of the redundancy present in natural languages, can be changed greatly by moving only a few digits. This makes it useful in cryptography, where simple transpositions can create completely new sentences. Finally, the system can be used to take information the computer already understands, such as programming code, and translate it into natural language or into another programming language. With new computer systems being created daily, there is a great need for a reliable way to transfer data and programs between various operating systems.

ELSIE -- An Optimized Digital Logic Design System

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The goal of this project was to develop a computer program that will generate an optimized digital logic gate network from a truth table. The resulting program, named Elsie, speeds the design process by automating the design of combinational networks.

The designer inputs a truth table specifying the desired input and output combinations. The first step is to reduce the table to a Boolean equation. Elsie uses a computerized variation of the Karnaugh map process to reduce the table to prime implicants.

The second step is to factor out common terms from the equation. Elsie uses an algorithm of my own design to find the set of factors that will generate the optimal Boolean equation. This step typically reduces the cost of implementing the equation by 30 to 50 percent.

Next, the Boolean equation is implemented as a logic gate network using standard AND, OR, and Invert gates. Finally, the gate network is drawn as a schematic. This output schematic is in the form of a DXF file (Drawing Exchange File) suitable for input to a CAD system (such as AutoCAD).

Elsie is written in the 'C' programming langauge and is able to generate and reduce gate networks quickly. The run time increases exponentially with the number of input terminals in the network. Networks with two or three input terminals require several seconds to generate, four inputs require a half-minute, five inputs require several minutes, and six inputs require up to an hour to process.

#Honorable Mention - Association for Computing Machinery

COUPLED PENDULUM SIMULATIONS

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In a coupled pendulum system, energy is periodically transferred between the two pendulums through some form of energy transferring medium. The objective of this research was to determine the specific mathematical relationships that guide the motions of a coupled pendulum and use the relationships to create a program which can analyse any system that behaves like a coupled pendulum

To find the relationships, a pendulum system was made from two pool balls serving as pendulum bobs suspended by three meter lengths of high strength surgical cotton. A steel bar was then attached to the center of the two pendulum strings so that it could freely transfer energy between the two pendulums. From a position perpendicular and above the motion of the two pendulums, a video camera was placed to film the coupled pendulum in motion. Two thousand one-hundred separate pieces of data were taken from the videotapings to create energy graphs of the system. With the completed energy graphs, trigonometric functions were determined which matched the pendulum motions.

Finally, a program was written that utilized the developed functions to create a simulation of pendulum motion and four other data analysis techniques. Comparing to the real-world coupled pendulum system, a high degree of correspondance was found when the correct system specifications were given.

#Second Award - General Motors ISEF/Computer Science

OBJECT RECOGNITION: STEPPING STONE TO ARTIFICIAL INTELLIGENCE

White, Danny
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This science project deals with the subject of artificial intelligence as compared to human or natural intelligence. The purpose of the overall system is to teach the computer to think for itself by utilizing what it already knows. The procedure for this lesson in learning is built upon the foundations of human intelligence and paralleled by a system of Pascal programs on an Apple //e Microcomputer. The first step in the intelligence parallel is Instruction. As a child, the human learns his first objects, images, etc. by first "seeing" them and then receiving information on what they are. A primary example is a young child first learning what his shoes are. He is shown the shoes by his mother and then she tells what they are. Much the same is the first part of this project. The computer "sees" the objects by use of the Object Scanner and then receives information about the objects. The second and valuable part of the intelligence parallel is the Recognition sequence. In the parallel to human intelligence, the child now remembers certain aspects about his shoes, such as color, style, size, etc., and recognize his shoes among other objects. Moreover, the child can now recognize any pair of shoes by comparing them to the basic properties that he learned about his own shoes. The computer can also recognize an object that it has already learned or recognize a new object by comparing it to what it knows about other objects. The recognition of objects enables the computer to learn new things in basically the same way that the child can learn his new objects.

#Fourth Award - General Motors ISEF/Computer Science

COMPUTER-AIDED MOLECULAR MODELING

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Computer graphics have always been an interesting concept, and since the advent of the low-cost graphics processors, such imagery as computer-generated molecular structures has become possible.

This three-dimensional molecular-modeling application was written in "C" on the Amiga to take advantage of the tremendous graphics power of the machine. The program was written as a result of interest in computer graphics and also as a way to learn the "C" programming language.

The program uses a joystick and mouse to manipulate complex molecular structures. The molecules can be displayed on the screen in many different ways, such as a wire-frame or smooth-shaded spheres, and a sorting algorithm is implemented to allow for a "perspective" view of the molecule, so "farther-away" atoms appear "behind" the others.

The program will allow the user to construct complex molecular structures right on the screen with the use of a mouse. By selecting the type of atom and bond type, and properly positioning it on the screen, the user can build on to exiting structures with ease. With just a few clicks of the mouse button, the user can attach an atom directly on to a bond of another atom. The program computes the bond angles, distances, and coordinates automatically. This approach offers ease of use that no other sub-mainframe modeling system can emulate, because the user doesn't have to hand-calculate the molecular coordinates of the structure.

#First Award - General Motors ISEF/Computer Science

Voice Recognition: How Affective is it as Another Input Device on the Commodore 64?

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Materials- Commodore 64, 1541 Disk Drive, Voice Module, Commodore 64 User's Guide

Problem- Can the Voice Module be another input device on the Commodore 64? Will it be as affective as the keyboard, and what other uses could it be used for?

Procedure- I analyzed the Black Jack game that came with the voice module. I figured out how they used basic to communicate with the computer. I wrote a program allowing programing of the computer with voice.

Observation- Voice basic was not quite as fast since templates were often loaded to proced with the program. It was also not as affective since voice patterns can be mistaken.

Conclusion- The voice module can be used as another input device on the Commodore 64. It is not as affective as the keyboard, and it could be used for simplifing programs and for people who can not type.

#Honorable Mention - Federal Aviation Administration

# DESIGN AND EVALUATION OF AN EXPERIMENTAL SORTING ALGORITHM

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In this experiment, this researcher designed a sorting algorithm which sorted data into bins based on ASCII values. The sort then put the data back into the original array in order. This researcher then compared the experimental sorting algorithm with all available algorithms of other programmers. It was found that the experimental sort was faster than most of the sorting algorithms for sorting numbers and was the fastest for sorting strings.

#Honorable Mention - Upsilon Pi Epsilon, The National Computer Science Honor Society

INTERFACE OF MICROCOMPUTER & RADIO CONTROLLED ROBOT

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The purpose of the project is to interface a microcomputer to the transmitter of a radio controlled robot. The software takes control of the robot and performs all the normal functions which are usually controlled by pushing buttons on the transmitter.

The first step was to design an interface for the Apple computer. This interface was then connected to the transmitter of the robot. The next step was to write software that would make the transmitter send signals to the robot to make it perform certain tasks.

This system has many applications and possibilities. For instance, in an unmanned fighter plane, a ground based computer would interpret signals from the plane and tell the on-board flight computer to react accordingly. Other examples include satellite control, guided missiles, unmanned combat tanks, fire-fighting robots, industrial work robots, and many others.

This project proved very successful, and will be applicable in countless areas in the future.

THREE DIMENSIONAL GRAPHICS
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Last year's problem was that by using simple mathematical equations, a computer screen could show a three-dimensional representation of an object on a two-dimensional plane. This year's problem was to design a faster way to plot and perspectively view these surfaces.

Last year I found, by using simple mathematical formulas and a graphics language called Comal, three-dimensional surfaces could be generated and depicted on a two-dimensional surface. This year the mathematical formulas were changed and two additional programs developed to facilitate faster execution of the graphics. The first program added was designed to plot a point of origin on the screen and then draw from point to point around the origin. The third program takes into account the phenomena that as an object approaches the horizon, it appears to become smaller.

By using last year's program and the two programs developed this year, it was found that three-dimensional graphics can be plotted and illustrated on a two-dimensional plane. After developing the programs, applications were sought whereby the programs could be used for practical purposes. One such application was to use three-dimensional graphics to plot the topography of a designated area. In order to accomplish this purpose, an area was identified on a topographic map and the elevations plotted on a worksheet. The area was then graphically depicted by drawing from point to point. After this was accomplished, a segment of the plotted area was then mathematically and graphically eroded in three dimensions.

EARTH AND SPACE SCIENCES

STUDY OF THE BEHAVIOR OF ANT-LION: EFFECT OF THE SOIL
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Ext. San Isidro, Luis M. Rodríguez #8, Sabana Grande, PR 00747

Myrmeleon insertus -Hagli- is a member of the Myrmeleonidae family which is commonly known as the ant-lion. This name comes from the fact that this insect's larvae feeds itself from ants.

Until now some studies have been performed an the development and ecology of this animal but no direct emphasis has been given to the soil. The purpose of this investigation is to determine the effect the soil has in the construction of the cone. Also especial attention will be given to the physical aspects involved in the throwing of soil particles.

The ant-lion builds traps in a cone form. After making 247 combinations and analizing this structure, it was found that the particle size has an effect in the construction of the cone.

The results revealed that the effect of the soil on the diameter of the cone is that it tends to gain with .18mm particles and it tends to diminish with .125mm particles.

#Third Award - Entomological Society of America
Fourth Award - General Motors ISEF/Earth and Space Sciences

# TILT ANGLES OF JOVIAN DECAMETRIC RADIATIONS

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The planet Jupiter is a major source of decametric radiation. As these radio waves travel to Earth, they meet plasma fields such as the Earth's ionosphere. These plasma fields cause the polarization ellipse of these radio waves to rotate. When the rotated radio waves encounter a dipole antenna on Earth, patterns known as Faraday fringes are recorded.

The purpose of this study was to use these patterns to derive the original value for the tilt angle of the major axis of the polarization ellipse relative to Jupiter's rotational and magnetic axes. The data for this study was collected from the University of Florida radio observatory near Oldtown, Florida. Using a modified linear regression the tilt angle was calculated.

It was found that there were two maxima in the values for the tilt angle. It is believed that these represent two sources of Io-B radiation. Further research is necessary to decide if the sources exist in the same or in different hemispheres of Jupiter.

#First Award - National Aeronautics and Space Administration
First Award - U.S. Navy

HOW WIND FLOWS AROUND VARIOUS MAN-MADE DESIGNS

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Earth Science is the study of how the elements of the Earth affect our lives. In my project I used a home-made wind tunnel to demonstrate how wind flows around various objects such as cars, boats, and buildings. After building a wind tunnel, I used it to test shapes of boats, buildings, and cars and took photographs. Using a novel method, I recorded the results and compared the shapes, in both the x and y axes. I then compared the sloping shapes to the box shapes to the step shapes. Finally, I recorded how each compared and found averages to show the comparisons. The shapes I used were from illustrations in books the I have either seen or have read. These shapes can be seen in everyday life in our boats, cars, and buildings.

PALEONTOLOGY OF PAHASAPA LIMESTONE

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No research has ever been done to identify and classify the fossils in the Pahasapa Formation. This project was an attempt to discover what fossils are in this formation.

Specimens were collected, studied, and if possible,defined. Then their identification was attempted using the classification in Invertebrate Fossils by Moore, Lalicker, and Fischer.

Five kinds of fossils were found. They include Lophophyllids (Horn Corals), Syringopora, Crinoids, a Gastropod, and shells which are probably Spirifers. A great deal of further study and identification needs to be done on this formation.

#SEISMOLOGY, THE STUDY OF EARTHQUAKES

Lloyd, Geoff C.
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Generally, when someone mentions an earthquake most people picture a quick jolt at the surface of the earth which shakes a few buildings in that one area. This is only partially correct since waves sent out by earthquakes, don't merely travel to the surface, but also throughout the earth. On this basis, these waves can be classified into two groups; surface waves, and body waves. Of the two, body waves are far more useful to Seismologists, since they can be detected, using seismographs, by stations around the world. These instruments record the ground motion along one axis, produced by each wave on seismograms. Thus, in order to obtain a complete record, three seismographs must be used (north-south, east-west, and vertical). It is from these continuous line graphs that the majority of the information regarding an earthquake stems. This is the objective of my project; to fully explain and demonstrate how to interpret seismograms. Based on just three seismograms of an earthquake, recorded at one station, several facts may be obtained. First, the different waves arriving can be isolated (finding their phase, travel-time, ground movement, and period). Also, the magnitude, distance, epicenter, and origin time of the earthquake can be determined. In my exhibit, using three seismograms of an Alaskan earthquake recorded at The LaMont Doherty Geological Observatory, I was able to calculate the magnitude using logarithms. Also, I identified some of the more prominent waves and used this data to find the distance as well as the origin time of the earthquake.

#Fourth Award - General Motors ISEF/Earth and Space Sciences

ELECTRICAL DISPLACEMENT OF INDOLE-3-ACETIC ACID FOR GROWING ROOTS IN SPACE

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Recent attempts of trying to germinate seeds in space has presented problems in controlling the direction of root growth and has led to an increase in funding for the study of root gravitropisms. Research has centered on the roles of calcium and Indole-3-Acetic Acid (IAA) in root gravitropisms. In prior years this investigation has shown that roots suspended in water in an electrical field respond positively toward the positive electrode. This technique was used to clarify the role of calcium and IAA. Ethylene dinitrilo tetraacetic acid (EDTA) was used to deplete roots of calcium. 2,3,5-triiodobenzoic acid (TIBA) was used to inhibit the transport of IAA. Untreated roots and roots treated with EDTA, TIBA, and both EDTA and TIBA were suspended between electrodes and their rate of curvature was measured for 1 hour. The untreated roots and the EDTA treated roots showed the most curvature. The TIBA treated roots and TIBA and EDTA treated roots showed negligible curvature to the positive electrode. The lack of movement by the roots treated with TIBA and the similar root curvature of the control and EDTA treated roots indicates the IAA and not calcium is responsible for gravitropic curvature. The clarification of the role of IAA and its electro-translocation could be used to control the direction of root growth in space.

#First Award - American Astronautical Society
First Award - U.S. Air Force
Second Award - General Motors ISEF/Earth and Space Sciences

# A COMPARATIVE PHYSICO-CHEMICAL STUDY OF SANDS FROM PUERTO RICAN BEACHES: WITH SPECIAL ATTENTION TO THE ORDINATION OF CONTINUOUSLY VARYING COMMUNITIES

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Beaches are among the most beautiful spots one can find in this World of ours. Puerto Rico, a tiny island in the Caribbean, is blessed with an enormous amount of sandy beaches. These treasures of nature share in all cases their appearance but they all have their pecular identity. Sharing many things in common, beaches in Puerto Rico differ a lot.

This study represents an attempt to study the physico-chemical traits of the sand from 32 beaches around Puerto Rico. Special attention is being placed on the ordination of continuosly varying sandy beach communities. The sand has been analyzed for calcium and organic matter contents. Its color, particle density, bulk density, percent of porosity or pore size has been determined. Particle size analysis has been carried out and analyzed with the aid of a computer. The sand has been classified into silt, very fine and fine, medium, coarse and very coarse. The rate of filtration of water for each sand as well as the rate of retention have been established. A penetration test for each sand has been carried out against two different objects. A permeability test for each sand has also been performed and a thermal conduction test is planned.

The sea water at each station has been analyzed for disolved oxygen, pH, salinity, refractive index, temperature and carbon dioxide. The reflection of sunlight has also been measured.

A careful study of the most visible communities at each station has been carried out. The members of the sandy beach community at each beach have been identified. Particular attention has been given to those having the ability to borrow into the sand at the sea shoreline.
A comparative study of these communities has been carried out.

#First Award - Association for Women Geoscientists Foundation
First Award - Eastman Kodak Company
Third Award - Marine Technology Society/U.S. Naval Institute

ON A CLOUDY DAY YOU CAN SEE FOREVER WITH PHASE CONJUGATION

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Did you ever wish that you could see forever on a cloudy day? If you knew about phase conjugation, this miracle would be possible. This project investigates phase conjugation by stimulated Brillouin scattering (SBS). In a regular mirror, the reflected beam preserves the ordering of the input beam. In a phase conjugate mirror, the reflected beam reverses the ordering so that it retraces the path of the input beam. In the first experiment, a laser beam was partially blocked by a knife edge to form a square wave pattern which was focused into a phase conjugate mirror. Two factors were varied to improve the fidelity: the focal length of the lens and laser intensity. It was found that a short focal length lens and a high laser intensity produce the best reproduction of the input image, and that phase conjugation reproduces low frequency components best. A second experiment was performed to investigate practical applications. A laser beam was distorted using a helium distorter and reflected. Both a SBS cell and regular mirror were tested to determine how well the distorted beam was restored. The ordinary mirror distorted the pattern further. However, the SBS cell produced a near perfect image of the input beam. Thus, it was found that phase conjugation can correct distortions. This property can be applied in tracking satellites or communicating analog pictures in fiber optics. Thus, phase conjugation will play an increasingly important role in the future.

#OPTICAL FIBER SEISMOMETER

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The Optical Fiber Seismometer is an inexpensive yet extremely sensitive device which has the ability to detect distant earthquakes and other seismic activity by measuring the change in light intensity from a light source below a pendulum. The changes in light intensity are carried to a signal processor by an optical fiber which converts the change in intensity to a change in voltage. A computer can then translate the different voltages into movements of the pen of an x-y plotter. The plotter then draws a trace similar to that produced by a typical chart recorder. The trace is then analyzed to determine if any activity is present on the paper. Any unusual fluctuations are compared with a record from the Geological Survey to determine if an earthquake or other seismic activity has been detected.

As of February 1, 1987, the Optical Fiber Seismometer, which is located in south central Texas, has detected the seismic waves of two underground nuclear tests in Nevada (a distance of about 1200 miles). It has also recorded many possible earthquakes and numerous cultural seismic disturbances such as trains and heavy trucks within a radius of several miles.

#Third Award - General Motors ISEF/Earth and Space Sciences
Alternate - Society of Exploration Geophysicists

There's Gold in Them There Trees!

Karen McDonald
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The purpose of my project is to determine if Nuetron Activation Analysis of leaf and twig samples from trees in semi-arid areas could be used to prospect for gold. I also wish to find if the tree's leaves or twigs will contain the most gold. I believe, based on the fact that underground gold will be absorbed into trees by their roots and on research conducted by C.A. Girling and J.P. Peterson*, that the leaves of trees will contain the most gold.

The first step in my procedure was to collect leaf and twig samples from known gold sources in the Santa Rita Mountains, Arizona. The samples were then oven dried, weighed, ashed, and weighed again. Next, portions of each sample were put into a vial, and the contents were weighed.

Finally the samples were irradiated in a TRIGA** type nuclear reactor at the University of Arizona. The gamma ray energy peaks of each newly formed radioactive elements were counted using a solid state germanium detector.

After collecting all my results, I found that twigs contained the most amounts of gold in seven of eight cases analyzed. This shows that twigs are the best source for detecting gold in semi arid areas. Therefore, the best results can be obtained by collecting twigs instead of leaves.

*Girling, C.A. & Peterson, P.J., "Gold and Arsenic Concentrations in Plants as an Indication of Gold Mineralization", The Science of the Total Environment, V.10: 79-84, 1978

**Training Research Isotope Reactor, by General Atomic

#Second Award - Association for Women Geoscientists Foundation

#ELECTRONICALLY ENHANCED LASER SEISMOGRAPH

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My project, which I have been working on for two years, is a new type of supersensitive seismograph based on a Michelson's Interferometer. A laser is fired into a beamsplitter, dividing it into two beams. One beam hits a stationary mirror, the other hits a mirror sensitive to vibration. The beams are reflected by the mirrors back into the beamsplitter, where they are rejoined. If the moveable mirror has shifted as little as 158 billionths of a meter (.00000645 inches) the beam interfers with itself. This change in the light is detected by a photodiode, refined by a Schmidt Trigger, counted by a multistage TTL counter, and fed into my computer. Using software I developed, the computer analyzes and stores the seismic data.

My project is not one project, but several projects combined into one. It is a project in geophysics, optics, electronics, engineering, and computer science. My project also has applications in many different areas. It can be altered to meterology, surgery, metalurgy, navigation, construction, or any field that requires precise measurements. Before I started work on my project, I discussed its feasibility with MIT's physics department and laser experts at NASA. MIT thought my idea was impossible, but NASA's experts disagreed. They said that even though my concept was unlike any they had seen, it appeared to be a promising area for further research. After giving me this encouragement, NASA asked me to inform them of my results. Not only has my project taught me about optics, it has taught me that anything can be accomplished with enough effort.

#Alternate - Society of Exploration Geophysicists

FLOPPY MIRROR OPTICS

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In order to extend man's depth of vision into the universe he will have to build telescopes an order of magnitude larger than those which exist today. Current telescope construction techniques can not simply be scaled up. New designs must be developed.

This experiment was designed to determine the feasibility of a technique to be used in building large telescopes rapidly and inexpensively. A simple partial vacuum was used to form an approximation of the required surface. The resulting surface was then fine tuned through a set of 16 screws which allow for small adjustments in the shape of the surface.

It is possible to mechanically bend a surface into a parabolic shape with sufficient accuracy that it can be used for astronomical observations. While in theory a partial vacuum will produce a perfect parabola, actual experiments indicate deviations from the parabolic shape. Overcoming these aberrations was accomplished by a manual override system. Analysis of the surface through the use of the Foucault test and actual observations of the moon indicate that the manual override system can correct these aberrations to a degree sufficient to permit stellar observations.

#Second Award - U.S. Air Force

RELATIONSHIPS BETWEEN IONOSPHERIC ACTIVITY AND OTHER INTERACTING PHENOMENA

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PURPOSE: The basic reason for this investigation was to develop a better understanding of the ionosphere and the other phenomena which interact with it.

HYPOTHESES: 1. Solar flares influence ionospheric activity by creating higher electron densities, which lower signal strength.

2. Geomagnetic storms create disturbances in the ionosphere.

3. Currents induced in the upper atmosphere induce electrical currents in the earth.

PROCEDURE: Observations were obtained from July 7-Nov. 12, 1986 using a previously constructed antenna, a riometer, and a chart recorder. These observations were then analyzed with reports on solar activity to see if there was a cause and effect relationship between solar flares and ionospheric activity.

A new system was designed and constructed by the investigator that would measure telluric currents within the earth. This data could then be used to look for relationships in solar-terrestrial interaction.

CONCLUSIONS: After careful study and analysis of the data was complete, the investigator deduced the following:

1. There seems to be no predictable pattern between ionospheric activity and solar ejecta or geomagnetic storms.
2. Solar ejecta cause higher electron densities in the ionosphere.
3. No conclusion can be drawn about telluric currents and their effect on the ionosphere because of insufficient data.

#SPECTROSCOPIC, X-RAY, AND RADIO ANALYSIS OF QSO NEBULOSITY

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Although it is now generally recognized that most, if not all, QSOs are surrounded by some sort of nebulosity, the precise nature of this extended material remains a mystery. A more crucial understanding of the nature of QSOs and their correlations with underlying galaxies is desired. The importance of understanding the relationship between QSOs and their "host" galaxies lies in its implications both for the formation of QSOs and for the evolution of galaxies. To further elucidate the remaining QSO-Galaxy enigma, this investigation was delineated.

In this six year investigation an attempt to determine the morphology of a selected QSO sample via the comparison of nuclear and nebular spectra, analysis of spectral index (X-ray and radio) measurements, multiple regression correlaion, and statistical analysis of variance ensued. The results manifested a sharp dichotomy between objects of the sample, indicating two morphological types, possibly attributable to evolution and their stage in life.

#First Award - General Motors ISEF/Earth and Space Sciences
First Award - Optical Society of America
Second Award - Ball Corporation
Operation Cherry Blossom Trip - U.S. Army
Scholarship - U.S. Navy
Honorable Mention - National Aeronautics and Space Administration

# HEATING/COOLING APPLICATIONS OF A SPIRAL VORTEX TUBE

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The vortex tube is a device utilizing the effects on air as it is run through a spiral tube. The device consists of a supply of compressed air running through a t-shaped pipe. The air enters through the bottom of the "T", and at the intersection there is a one turn spiral which causes the heated air molecules to move to the outside of the tube, and the cooled molecules to the inside. If a washer is placed in the cool air output, it will stop the heated air from escaping out with cooled air, thus producing heated and cooled air simultaneously.

This device has many applications in refrigeration and home climate systems, but a device has never been built utilizing this concept. The researcher will first build a water heater/ cooler utilizing this system for a home of maximum energy efficiency, and then experiment to see if the device works with water instead of air as a medium, for use in a hot/cold water system.

The purpose of this experiment is to build and analyse the efficiency of a home hot water heating/cooling system utilizing the spiral vortex method.

It is hypothesized that the seperation in temperature due to radial direction will result in a fuel efficient home heating/cooling system. The overall feasibility of the system using water as a medium instead of air does not appear optomistic, though. Previous research points to the fact that the use of water instead of air is not as efficient, or not even possible.

#First Award - U.S. Army
First Award - U.S. Department of Energy

THE EFFICIENCY OF EARTH SHELTERED HOMES

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In 1986, two model homes were constructed to prove that earth sheltered homes were more energy efficient than surface built homes. The testing results proved that earth sheltered homes are more energy efficient than surface built homes. In 1987, the home models underwent extensive testing to determine how much more energy efficient the earth shelterd home was than the surface built home. The earth sheltered home was covered with 3 1/2 inches of different soils: gravel, black topsoil, and caliche. This was to determine hou much more energy efficient the earth home was with different types of soils. There were three tests done on each soil for three one-hour intervals. The temperatures were increased by mounting two heatlamp bulbs above both homes. The temperatures were taken by "Annie", an electronic temperature analyzer. After each hour of testing for each soil, the temperature increases were recorded. Then the percentage of efficiency was found by using the formula, Efficiency $= 1 - T_2/T_1 \times 100 = \%$. This showed how much more energy efficient the earth sheltered home was than the surface built home. The gravel covered earth shelterd home proved to be 10.6% more energy efficient than the surface built home. The black topsoil covered earth sheltered home proved to be 11.1% more energy efficient than the surface built home. The caliche covered earth sheltered home proved to be 11.2% more energy efficient than the surface built home. In summary, this earth sheltered home proved to be an average of 11.0% more energy efficient than the surface built home.

EXCAVATION OF ARCHAIC BURNED ROCK MIDDENS

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PURPOSE: To excavate two burned rock middens in Real County and collect data to substantiate current theories on structure and origin.

To compare these two sites with a previously excavated site in Milam County to find components of site selection that are common throughout Central Texas Indian cultures.

PROCEDURE: Surveying and surface excavation were completed before excavation by the grid method. Artifacts were removed using trowels and picks, and photographed in situ. Artifacts were later examined and classified.

RESULTS: The Camp Wood site yielded mostly Perdernales points dating it to the Round Rock Phase (3,400-2,600 B.P.). The midden is a type I utilized for acorn and deer processing. The Leaky site yielded mostly Frio points dating it to the Twin Sisters Phase (1,750-1,400 B.P.). It is a Type IV midden utilized to process deer and small animals. The Milam County is a Neoarchaic site containing burials, hearths, and bison bones.

The primary element in these sites is water and proximity to game and vegetal sources. Secondary elements such as flint resources and the safe view of game and enemies are also important in these site selections.

CONCLUSIONS: Burned rock middens are deposits that were established in the same area through many years. Most were used to process food, either animal or vegetal. Indians throughout Central Texas relied on similar resources and hence had similar settlement patterns.

APPLICATIONS: If we understand the structure of sites and settlement patterns, then we can advance to study more specific processes such as food preparation, manufacture and social structure.

SATELLITES - THE SILENT VOYAGERS OF THE NIGHT

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The purpose of this investigation was to ascertain and develop a method to determine the angular velocity of a satellite, calculate the height of a satellite through optical observations only, and to study the relationship between the angular velocity and height of a satellite.

The satellites that were chosen for observation were selected because their orbits were stable and near-circular. Only this type of orbit was suitable for the required formulas. The appearances of the selected satellites were predicted by a computer program based on data distributed by NASA.

Through the construction of a modified pair of binoculars equipped with a camera, the angular velocity of a satellite was determined by photographic means. With the knowledge of the angular velocity of a satellite along with its observed maximum elevation above the horizon, a satellite's height was computed through a long series of formulas. By carrying out this procedure on several satellites, it was observed that as the angular velocity of a satellite increases, its height decreases. This observed relationship agrees with the laws of gravity which govern the orbits of satellites.

Through this investigation, several techniques for determining many factors in a satellite's orbit were developed and in the future these methods can provide a basis for more detailed studies into the behavior of SATELLITES. . . the silent voyagers of the night.

#SOIL ANALYSIS AND COMPARISON

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The relative amounts of macronutrients present in the soils of the red oaks and the red maples were compared to determine the influence of the trees on its soil. Both trees are broadleaved, deciduous, and common in the Washington, D.C. area. As a control, a sample of commercially-sold, nutrient rich potting soil was tested, and the macronutrients present in the area's bedrock were determined.

In order to gain an average soil analysis for each type of tree and limit the number of environmental factors involved, a number of samples were tested and averaged. The soil analysis conducted on each sample consisted of a test for phosphorus, potassium, and nitrogen (the three principal macronutrients needed by a plant) and also a pH test.

Initial studies in Silver Spring indicated that the red oak's soil contained higher amounts of the basic nutrients, and its pH was lower than that of the maple. To determine whether the oaks' richer soil was a result of the oaks' leaves, the leaves were tested.

After conducting the same tests, no significant differences were found. Later the same macronutrient tests were performed on red oaks and red maples present in an undisturbed environment. These results showed that the soils of both types of trees are similar in macronutrient levels. Futhermore, an elevation study was conducted on both types of trees. Differences in the number of red oaks and red maples were found when correlated to elevation. It was determined that red oaks can be found at higher elevations than the red maple.

#First Award - American Society of Agronomy

POPULATION DENSITY OF SNAIL *THIARA GRANIFERA* AT BAYAMON RIVER

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The freshwater snail Thiara granifera was introduced to Puerto Rico around 1953 (Ferguson and Richards, 1963). Since then the specie has spread to most abundant snails of our freshwater environments. Thiara populations seem be important since they apparently displace the bilharzia snail *Biomphalaria glabrata* from thier natural habitats and serve as food for the sunfish *Lepomis microlophus*. The main objectives of the present work were to study the distribution and density of the snail *Thiara granifera* in the Bayamón River in relation to certain enviromental parameters. The same five stations of the previous work were established. The following parameters were measured during the afternoon hours: Ca, Mg, K, Na ion concentration, pH, type of substrate, type of flow, relative humidity, air, water, and substrate temperature, coliform bacteria and the number of snails (Thiara)/meter.^{2} The results showed that *Thiara granifera* thrives better in lotic waters when the calcium and magnesium concentrations are higher, the pH is slightly alcaline, the substrate consist of rocks and alluvial sands. It was found that there are significant difference in the number of snail present when low water levels or high water levels prevail according to Mann-Withnew U - Test statistical analysis. There was significant difference between the number of snails and the parameters measured at the five stations according to a T- Distribution analysis. There is a significant difference between maximum and minimum weight of the snails as well as the lenght and width in relation to the parameters measured at each station.

# SPECKLE AUTOCORRELATION FUNCTION ANALYSIS OF 4-METER TELESCOPE IMAGES OF R AQUARII

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R Aquarii is a variable symboitic star with a strange "jet" feature and circumstellar nebulosity. Its morphology changes each year and it appears different at different wavelengths. Because it is an approximate 12th magnitude star, it is difficult to study. Since Speckle Interferometry reconstructs images to the diffraction limit of the telescope, R Aquarii is analyzed using this in hopes of resolving the star to find possible cause for the jet feature.

The video recorded speckelgrams from the 4-meter telescope are digitized, reduced, debiased and filtered to create a deconvolved autocorrelation of the image. The results are compared with previous optical and radio wavelength maps and three possibilities arise:

1- the secondary component
2- bright H alpha feature
3- gas emissions in the stellar neighborhood

However, fringes in the power spectrum suggest the secondary component. The results are then compared with mathematical models to get an idea of what should be seen.

Continued research is categorized into three areas. The image must go through the final reconstruction phase to determine if the image is actually symmetrical. Longer observations must be done to improve the signal to noise ratio. Observations must also be done in different wavelengths to validate the H alpha feature possibility.

#Second Award - Society of Photographic Scientists and Engineers
Third Award - General Motors ISEF/Earth and Space Sciences

THE EFFECT OF ACID RAIN ON THE WEATHERING OF MISSISSIPPIAN LIMESTONE IN THE OGDEN RIVER DRAINAGE

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Acid rain and its effects on the environment are a common news story today. Acid rain is created when the pollutants sulfuric and nitric acid, put into the air by coal and oil burning indrustries, combine with oxygen and water. This mixture returns to the earth in the form of snow rain, or mist.

The effect of acid rain on limestone, calcium carbonate ($CaCO3$) and sediments, can be measured. Water samples were collected and tested at three specific locationsalong the river in Ogden canyon, Utah, where the rock formations are mainly limestone. The water was tested for temp., pH level, $CO2$, and total hardness using a Hach kit approved by the E.P.A In the laboratory, Two types of acid rain, with a pH level of approx 4.0 were created, one with sulfuric acid, the other with nitric acid. The water was chilled to a temp. of 5°C, similar to the river water.

To find the amount of $CaCO3$ that would dissolve in the acid water, powdered $CaCO3$ was dissolved in the mixtures until saturated. That solution was filtered and poured into a preweighed beaker. After the water evaporated, the weight was measured and subtracted from the original to find the weight in grams of dissolved $CaCO3$. A system was set up to let acid rain drip down onto pieces of limestone to observe the actual effect.

From these experiments it was found that acid rain highly increases the weathering of limestone, however the Ogden rivr drainage in the area tested does not appear to have an acid rain problem currently.

ADAPTATIONS OF ANCIENT OYSTERS TO MUDDY ENVIRONMENTS

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Oysters live today in environments having firm, sandy sea floors which have current and wave activity. These oysters have similar triangular shapes. Fossil oysters found in ancient claystones have diverse forms that are adaptations for surviving in muddy environments. These forms include the iceberg for elevation, gryphaeate for support and buoyancy, snowshoe for support, spinose for anchoring, and thin, non-ornamental for cementation. To determine why the shapes of fossil oysters that lived in ancient chalks are so different from oysters living today, the fossils and sediments of the Cretaceous Demopolis Formation at Rockhill, Mississippi, were studied.

Demopolis chalk particles were compared to the size of sediment where oysters live today and were found to be smaller and made up of clay and microscopic organisms. No evidence of current or wave activity was found. The shape, condition, and distribution of the oysters in the chalk were compared to oysters living today and to fossil oysters of ancient claystones. The oysters in the chalk are randomly distributed, are in good condition, and have diverse shapes like the oysters of the ancient muddy claystone environments.

The diverse forms of the oysters in the chalk include the iceberg, gryphaeate, snowshoe, spinose and thin, non-ornamental. The chalks consisting of small particles and the oysters having diverse shapes indicate that environmental conditions in the ancient chalks in Mississippi and Alabama were similar to those of muddy claystone environments. These fossil oysters developed diverse shapes as adaptations to survive the hazards of sinking into the chalks or having their feeding and breathing mechanisms clogged by the small sediment particles.

# CYGNUS X-3: QUARK PARTICLE TRACKS IN PALMS

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A survey of over 2000 christmas and coconut palms from Key West to Ft. Pierce to Sarasota, have all revealed apparent cosmic ray track damage. In July 1985, the palms showed damage with the same fronds, 3rd, 4th, 5th, and 6th from center. Christmas palms will exhibit a band of small holes of about 4 cm (1 1/2") in width. Fan palms may exhibit a yellow band in a 3/4 circle pattern as the leaf unfolds from the center stalk. Coconut palms will exhibit a yellow band of about 10 cm (4") in width from the radiation strike. Severe destruction of the leaf tissue from the cosmic hit may also form a crew cut appearance, pony tail droop, or arrowhead shape of the frond. Short angle tracks and fission marks when a nuclear collision or evaporation occurred, producing forks, crows feet, and star burst patterns are visible on some palm samples, for the October 1983, 1984, and 1985 cosmic events.

Cygnus X-3, in the constellation, Cygnus the Swan, also know as the Northern Cross, erupts about every 367 days, producing a powerful super cosmic ray outburst. Cygnus X-3 may be the source, and a new unknown particle to particle physics may be producing the palm tissue danage. On October 11, 1986, an eruption was anticipated, and did not occur. If Cygnus X-3 is the source, then by April 1986, when the new fronds have grown out, and if these fronds are clear of damage marks, Cygnus X-3 as the source may be verified.

#First Award - Eastman Kodak Company
Third Award - General Motors ISEF/Earth and Space Sciences

#TRACKING THE ECLIPSE PERIODS OF VARIABLE STARS;A THREE YEAR STUDY

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Using the method previously developed by the researcher a novice who is familiar with the skies can make relatively accurate observations. In the third year of study a more difficult, advanced method of observation was developed for comparison with the original method. A Celestron-8 telescope with a power drive mechanism was purchased to assist in the new procedure in May 1986. Though observations made and photographs taken with this procedure would produce more accurate data in the end, it is far from a practical procedure for any backyard astronomer. The equipment assemblage is not stable enough to produce good photographs for data collection under anything less than perfect observing conditions.

Due to the lack of conclusive data obtained from the new method, the original method was at this time further tested and modified. These modifications included the use of filters. Since the black and white Tri-X film captures color as does the human eye it was assumed that yellow and blue filters would be most effective in shielding out unnecessary light pollution. According to the data obtained and the statistics applied the blue filter is the most effective.

In conclusion, the original method is the most practical for backyard astronomy. The more advanced equipment assemblage was too sensitive and not effective for use by the backyard astronomer. The use of filters was found to be effective and should be added to the equipment assemblage to obtain more accurate measurements using the proposed procedure.

#Fourth Award - General Motors ISEF/Earth and Space Sciences

ROOT ORIENTATION IN SPACE

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Geotropisms in roots and stems result from the movement of auxin in plants. If both root and stem are in a vertical position, there is no unequal auxin distribution from one side of the roots and stems to the other side. The roots grow straight down, and the stems grow straight up. In space, a reduced gravity force will make the geotropism response of growing plants almost nonexistent.

There are numerous problems that will be needed to be solved in order to grow plants in a low atmosphere and a reduced gravity environment. This investigation deals with only one problem, directional root growth.

The first investigation involved the white potato, geranium and corn plants. A voltage of 40 (copper electrodes) over a period of 40 minutes was used in the test procedure. All plants tested showed polar root directional motion.

In the second investigation a voltage range of 5 to 12V was used and the selected test plants were lima, petunia, tomato, bean, pinto and corn. Polar directional motion was detected. For about 50% of the plants tested lower voltage (5-6 volts) produced greater negative polar root directional motion; whereas, about 50% of the plants tested responded to higher voltages (11-12 volts).

A tropism involves the growth of the plant. For this reason most plant responses are slow. Photographic analysis was used to analysis the changing patterns of the roots.

# MOVEMENT OF BEACH SAND

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An experimental study was devised to determine 1) whether there is a net gain or loss of sand at the beach, 2) if sand elevation measurements at two points would accurately reveal the gain or loss and 3) if the movement of sand on opposite sides of a reef were similar. In January of 1984, points A and B were selected at South Cardiff State Beach, in California, for measuring and recording of sand elevations. Point A became the benchmark, and point B was later dropped. It was found that a 13 week time span during the summer/fall was the best time to compare annual sand gain and loss. From 1984 to 1985 9 cm of sand was lost, and from 1985 to 1986 15 cm was gained. In November, 1985, profiles of sand slopes were made to verify the accuracy of the point. A measuring rod was devised using PVC pipe and a surveyor's tape. It was determined that profiles give a more accurate picture, but weekly point measurements show definite trends. Point A is north of a reef, and in November, 1985, point C was selected south of the reef to determine the similarity of the sand movement. At Scripps Institution of Oceanography, it was shown that the profiles, using the principle of horizon leveling, were accurate by verifying with surveying instruments; and also determined the elevation above mean sea level (MSL) of points A and C. With this information, all of the profile and weekly data were converted to meters above MSL. Weekly measurments indicated that movement of sand north and south of the reef is not the same. However, seasonal profiles showed the two locations follow the same trend of sand gains and losses. Several more years of data need to be collected before definite trends can be determined.

#Second Award - General Motors ISEF/Earth and Space Sciences
Honorable Mention - Eastman Kodak Company

VIRGIN ISLANDS ENERGY INDEPENDENCE?

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When the sun which shines in the Virgin Islands is harnessed, we will not be buying any electricical power from the local utility! Instead we will be crediting our account for much of the electricity produced by the shiny panels of solar cells on our homes south-facing roof. The photovoltaic array produces so much electricity that this sample house may very well become a net energy producer in the Virgin Islands.

With the high cost of photovoltaic modules this system may not sound economically viable, but the cost of living in the Virgin Islands has been statistically found to be almost one and a half-times higher than any place under the United States flag; and the sun shines year round. Photovoltaic cells take approximately fifteen minutes to be charged and they produce as much as six volts of electricity without producing harmful pollution or hazards. These six volts were able to light four bolbs of forty volts. This form of energy is a very effective way in which the homes and businesses of Virgin Islanders can become independent from the high cost of power.

As opposed to the disadvantage of nuclear or oil energy, photovoltaic cells can: end air polution from power production; solar energy is safe, presenting few hazards for workers and none for the public; solar energy is kind to the environment requiring no ripping up of the land for mining or drilling; solar energy is an unlimited resource, we will never run out of it; solar energy is universal. The technology of solar energy utilization can function anywhere on our planet; best of all no utility will have a monopoly on the sun as an energy resource.

SOLAR FLIGHT

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Solar flight has only been marginally successful to date, but would be a tremendous asset if perfected. The purpose of this experiment was to explore the problem: Can a model airplane be designed to support the feasibility of solar flight?

Researching the theory of flight, aerodynamics, and solar power was the first step in designing this aircraft. The three major design changes went from a multiple wing, to a canard wing, and finally to a single high wing with a majority of flat surface for solar cells. Since, it had to be light, holes where put in the spars and supports of the wing. The fuselage was designed for stable flight and light weight. The horizontal stabilizer has a low profile and drag with minimal weight. The motor and prop were chosen for efficiency, wing area, and weight. Next, solar cells were purchased for the voltage requirements and mounted on the wing. The structure was covered with a plastic film, adding strength and surface area for lift. The solar cells, diodes, battery pack, and motor were wired when it was discovered that the solar cells did not meet their specifications. Due to the lack of time and funds, the Sunseeker was tested using the back up batteries of four AA batteries which provides a basis for the conclusions.

The Sunseeker flew proving that an aircraft can fly on electricity and that a mostly flat airfoil works. Finally, with the addition of enough solar cells, the Sunseeker will fly on solar power.

#DOES THE SIZE AND SHAPE OF A WINGLET EFFECT THE LIFT OF AN AIRCRAFT?

Day, Steven T.
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2844 Whittier Ave., Dayton, OH 45420

A winglet is a device on the tip of an aircraft wing that is used to reduce the drag of an aircraft. This project is a carry-over from one I did last year where I found that different sizes and shapes of winglets effect this drag. Based on those conclusions, I continued in the area of winglets to see if the lift of the aircraft is increased through their use. In order to find out if winglets increase the lift of an aircraft I made an aircraft and six winglets of different designs out of balsa wood. I then placed the aircraft in a windtunnel I built. I tested the aircraft with no winglets on it, and with each of the six winglet designs. The amount of lift produced was measured by my computer. I found that a winglet that is 13% as tall as the wing span of the aircraft wing will work the best in increasing the lift of an aircraft. From results the Air Force found, the winglet should be 15% as tall as the wingspan. I also found that the winglet should be the full width of the aircraft wing as opposed to only half of the width of the wing.

#Third Award - General Motors ISEF/Engineering
Alternate - U.S. Department of Energy

ENGINEERING

The Development of an Artificial Forearm
David J. Brown
Cumberland High School, Cumberland, RI 02864
10 Wagon Road, Cumberland, RI 02864

The main objective of this project is to create a working artificial forearm with two degrees of freedom controlled by a single human forearm muscle group.

Instead of using a conventional method of connection from the user to the device, the researcher invented a special forearm switch that completes an electric circuit through the contraction and subsequent enlargement of the forearm muscle group.

The prototype artificial forearm is the result of three years of design, construction, and operational testing. It has two degrees of freedom consisting of opening and closing the hand and rotating the wrist. Many principles of physics were applied in order to develop the electrical and mechanical aspects of the arm. The operating system consists of three direct current motors with associated battery power source, wiring, switches, and gears. The forearm switch activates one direct current motor which in turn, through a system of gears, selects a position on a two pole six position rotary switch. Depending upon rotary switch position, either of two reversible direct current motors is energized to control the hand or wrist functions.

*MULTIPRO 16: THE DAWN OF PERSONAL SUPER COMPUTERS
Ouellette, Edward J., Carman-Ainsworth HS, Flint, Mi 48504
5121 Briar Crest, Flint, Michigan, 48504

The problem I addressed was to design, construct and program an 8 node super parallel computer which outperforms the VAX supermini by a factor of 1.3, runs on 1/20 the power, occupies 1/10 the space, and is twenty times less expensive. My goal was to create one of the first one-hundred watt systems that interfaces with a myriad of home computers and advances their performance without sacrificing their huge, already-established software base. Researching parallel computers and programming an Intel iPSC d5 prompted the development of my system. After five hundred hours in design, I was prepared to document my circuitry. I spent over three hundred hours drawing the schematics and PC board layouts on an Intergraph CAD system, and one month prototyping. I was able to fashion a modular operating system with the Intel Series IV development stations. My project costs less than $7,000; it's portable and can outperform the IBM PC in speed tests by over 3,200 percent. Other outstanding features include modular 16-bit multiprocessor and coprocessor supports for easy maintenance, battery failure predetection, voice input port for speech recognition, 3 megabytes of non-volatile zero wait state memory expandable to 16 megabytes, 8 parallel ports, four-month battery protection for the RAM, a security keylock to prevent unauthorized use and to allow for custom system configurations, 8 built-in audio amplifiers for eight-channel stereo voice and sound applications, and leading edge components to assure minimal power requirements. Its uses are unlimited.

*London International Youth Science Fortnight Trip - U.S. Army
First Award - National Aeronautics and Space Administration
Second Award - General Motors ISEF/Engineering
Second Award - American Intellectual Property Law Association
Scholarship - U.S. Navy
Scholarship - U.S. Navy/NORDA

A THREE YEAR STUDY OF MARINE HULL DESIGN TESTING

Smith, Wesley E., Ft. Pierce Central H. S., Ft. Pierce, FL 33450
6414 Riverland DR., Ft. Pierce, FL 33482

The researcher planned to develop an apparatus to test planing hulls. The objective was to have the flume type machine push the water by the hull and obtain the same type of testing results as by using a tow tank. The researcher found that after working out the turbulence in the water the conditions were good for testing. With fifteen grams of weight the flume had to travel 3.16 feet per second to keep the boat still. This was fairly close to the 2.38 feet per second in the tow tank that was produced by fifteen grams of force.

The results show that the flume testing apparatus does produce similar results in testing hulls compared to the tow tank.

Research such as this can be a great improvement in the testing of marine efficiency and the ability to observe the boat for several minutes at a time.

NANOSECOND ELECTRIC PULSE DRIVERS FOR RARE GAS HALIDE EXCIMER LASERS

Gollin, Edward, South H.S., Valley Stream, NY 11582-3005
96 Home Street, Valley Stream, NY 11580

This project involves the design, construction, and operation of a device that can generate electric field pulses to power a rare gas halide excimer laser. The device built, a Blumlein circuit, is a field inversion generator which stores energy and is triggered to discharge the energy into a gas chamber. A surface discharge was designed to transform the stored energy into electric field waves that deliver this energy to the gas within several nanoseconds to satisfy the energy requirements of the lasing gases. Voltage probes were then built and calibrated to allow observation of electric pulses during operation. Pulses lasting approximately 13 nanoseconds, with voltage risetimes of 4 nanoseconds were observed.

# THE PHOTOVOLTAIC BIRD SCALE: PHASE II

Holmquist, Melvin
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201 Happy Hollow Road, Grand Rapids, MN 55744

The engineering purpose of the bird scale was to redesign and improve the accuracy of the device so that it would weigh birds, or possibly other vertebrae, in a non-threatening manner.

The scale would be callibrated using a set of standard weights and placed outside to collect data to verify its practicality and accuracy. It was concluded that birds frequented the scale without fear of the moveable perch, and the accuracy of the scale was greatly improved over the original version. The scale is delicate enough to detect weight variation while a bird is feeding!

#First Award - Patent and Trademark Office/U.S. Department of Commerce/
Patent and Trademark Office Society
Fourth Award - General Motors ISEF/Engineering

MEASUREMENT OF THE INSTANTANEOUS ACCELERATION OF AN AUTOMOBILE

Kevin William Bergner
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The purpose of this experiment was to build an accelerometer which would measure the acceleration of an automobile during foreward acceleration, braking and cornering. The problem was to measure the acceleration so it could be read instantaneously. The solution was to use the voltage out-put from two potentiometers hooked up independently of each other. One of the potentiometers measures the displacement of a mass during forward acceleration and braking. The second potentiometer measures the displacement during cornering. The mass acts as a pendulum with the angle of swing proportional to the acceleration of the automobile. The equation F=MA is used to find the acceleration, where F is the force and M is the mass. Using this formula, a conversion between voltage read from the potentiometers and the acceleration of the automobile in g's can be determined. Then different automobiles were tested during forward acceleration, braking and cornering. In the test for forward acceleration, the automobiles with the highest power/weight ratio had the greatest acceleration. The braking test was based upon weight-to-size and type of brakes. For the lateral test, a skid-pad was set up on a flat parking lot. If the automobile was to exceed the maximum lateral acceleration, the tires would lose traction and go into a spin. This accelerometer could be implemented as a safety device in an automobile, where it would sound a warning signal if the automobile was approaching maximum safe acceleration.

#THREE DIMENSIONAL ROBOTIC VISION

Milde, Michael N.
Riverside High School
115 Creekside Road Greer, S. C. 29651

The project consists of a computer, laser, camera, motors and related circuits. These allow the computer to 'see' what is in the environment around it. By rotating an object and projecting a laser beam on it, the computer can analyze the object in three dimensions.

Two interfaces have been designed which control two stepper motors, one light beam galvanometer, a digitizing camera and other smaller components. One of the stepper motors rotates the platform where an object is to be placed for viewing by the computer. The other stepper motor rotates a mirror at small angles to scan the object with the laser. The galvanometer mirror oscillates at 500 Hz to provide a vertical line of red light across the object. A laser is used with the galvanometer so that a clear, sharp line of light is produced.

A grid is projected on the object one line at a time and transferred to computer memory via the camera and interface. The geometry of the grid provides data for angle, depth and volume measurements. Both BASIC and assembly language are used to control the interfaces and manipulate this data.

The project works very well and can find the volume of objects with an error of 1% to 15%, depending on the complexity of the object. I am currently improving the project for applications in quality control measurements of gas turbine bucket air foils.

#First Award - General Motors Corporation
Second Award - Junior Engineering Technical Society
Honorable Mention - National Aeronautics and Space Administration

THE RIGIDITY OF POLYVINYLIDENE FLUORIDE DUE TO THE PIEZOELECTRICAL EFFECT

Ward, Matthew Loren, Northwestern H.S., Kokomo, Ind. 46901
402 Jeff Drive, Kokomo, Ind. 46901

The purpose of this experiment is to investigate new engineering uses for piezoelectric polymers. This experiment tested the rigidity of polyvinylidene fluoride film at varying voltages.

The experiment was performed using a 45.00 mm diameter diaphragm of polyvinylidene fluoride clamped and glued between two insulator sheets.

The control, a zero gram load, and two differing mass loads (0.2500 grams and 0.5000 grams) were then separately placed on the test disk and the amount of bending for each mass measured. Next, 15 voltages (500, 450, 400, 350, 300, 250, 200, 175, 150, 125, 100, 80, 60, 40, and 20 volts) were applied to the disk for 2 seconds prior to the loading of the test masses. Twenty seconds after loading, the concavity was measured to the nearest micron by a laser transit system. This procedure was repeated for each mass and the control at each respective voltage.

The results show that as voltage increased, the amount of bending decreased for both masses and the control; thus, rigidity increased with voltage. The relationship between rigidity and voltage was shown to be linear in form with rigidity being a direct function of voltage.

This experiment has direct applications in devices for the active control of vibrations. The same piezoelectrical element would be able both to sense and to cancel vibrations; therefore, making such devices simple and inexpensive.

DEVELOPING THE PADDLEWHEEL WINDMILL

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Wind... it represents roughly 20% of the sun's available potential energy, but as of yet man has been unable to find a way to efficiently harness this powerful, elusive force. In fact, the theoretical maximum efficiency of any aeroturbine has been set at 59.3%, and few modern machines, including the Darrieus and Savonius rotors, convert more than 40% of the wind's potential into usable power. My goal is simply to design a better windmill, if not one that can be heralded for its efficiency, then one that can be well-implemented on the basis of its simplicity and its applications in areas having low average annual wind speeds. My hopes of achieving this goal lie in a variation of the shielded-paddle aeroturbine concept, a self-conceived design that closely resembles an upright paddlewheel having symmetrical airfoils for blades.

Last year's study, Phase I, was the introductory stage. I tested several standard airfoils for their maximum lift coefficients, and I concluded that the possible applications of symmetrical airfoils should be explored. Research resumed this year with the construction of an improved wind tunnel and the testing of a symmetrical airfoil. Lift and drag measurements were taken at every 3° angle of attack, and these measurements were then used to find the respective coefficients. Finally, the coefficients were entered into two computer programs designed to analyze force vectors. The first program determined the best angle of attack for each of the blades while the second actually calculated the theoretical output of the working design. The results were enlightening and promising.

THE EFFECT OF AN ENCLOSURE ON THE ELECTRICAL AND ACOUSTIC FREQUENCY RESPONSE OF A SPEAKER

Kuhn, Leith, Cheltenham High School
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The purpose of this experiment was to determine how an enclosure affects the electrical and acoustic frequency response curves of a woofer. The experiment consisted of: the scientific construction of an enclosure, the electrical and acoustic testing of a driver, and talcum powder and qualitative listening tests. The enclosure was constructed to a specified volume and dimension. The electrical and acoustic testing consisted of a signal running through the driver and a monitoring voltmeter. A sound level meter (acoustic testing) and a voltmeter (electrical testing) were used to plot graphs, frequency versus sound or current, and construct frequency response curves from which resonances were studied. The talcum powder tests consisted of the observation of modal patterns (lines of nodes), when talcum powder was placed on the speaker cone. During these tests, the enclosure was tested: completely enclosed (control), with the back piece removed, and with a hole, varying in size, cut in the enclosure behind the driver.

The electrical testing resulted in the appearance of one or two resonances, depending upon the enclosure variation. This phenomenon was best explained by a system, a simple harmonic oscillator, in which there were two stationary and moving masses, and three springs, all interacting in different ways, depending upon the conditions of the enclosure. Through indoor and outdoor acoustic testing, it was concluded that, though enclosure design improved the frequency response curves, environmental conditions were more important to tests than background research stressed. The results of the talcum powder testing gave further support to, and a better understanding of, the working parts of a speaker. Finally, it was concluded that the enclosure variation greatly improved the physical quality of sound.

WAVEFORMS & VIBRATIONS

Hohn, Michael H., Ben Lomond H.S., Ogden, UT 84404
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The Purpose of the setup is to make waveforms, vibrations, and transients visible for analysis.
The Procedure was to build a circuit and write the software to drive it; the software also provides the display and a timebase for measuring duratiom of events. Used here was a Commodore 64 computer, disk drive and printer. The program is written entirely in 6502 assembly language. The circuit consists of two main parts: the input amplifier/filter and the A/D converter; a single IC is used to synchronize the computer to the converter for data transfer.
The results were grouped in the three above categories, and they were different for each. Waveforms' (regular sounds) frequencies seem to have relations to each other, both in frequency and amplitude: as the frequency goes up, the amplitude goes down. Vibrations' (mostly noises) frequencies seem to totally lack any kind of correlations; and third, transients (transitions from one state to another). The transients looked at were of short duration, and simply showed how the unit went from one state to another (i.e. a light bulb turning on).

A ROOM WITH A VIEW

Jackson, Scott A.
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7192 Via Romera, San Jose, CA 95139

There are numerous instances in which an outline of a room, a building, or an outdoor area is needed. Interior decorators, landscape architects, and homeowners often have need of an accurate map of the area they are working with.

One innovative way to produce this map would be through the use of the principles of sonar. The goal of this project was to design and construct a sonar ranging system which would produce an accurate map, drawn to scale, of any room.

The active sonar system that was developed made use of an inexpensive sonar transducer. An electronic circuit was build around this device, enabling it to transmit "pulses" in the form of audible clicks and then to receive the echoes of these clicks which came from the obstructions in front of it. This circuit was set upon a rotating turntable that was designed specifically for this application. The entire circuit was interfaced with a computer and a digital plotter. The computer determined the amount of time that elapsed from the moment the sonar emitted a click to the moment the echo was received. The Pascal computer program that was written to communicate with the sonar device then calculated the distance from the sonar to the nearest object. These distances were plotted by the program onto the digital plotter.

The results were interesting and often intriguing. It was determined that four fundamental problems would need to be solved before the sonar ranging system could be used in everyday situations. The results do indicate that such a sonar ranging system could indeed become a reality of the future.

#CAN WE TALK

Davis, Troy, MUSKOGEE HIGH SCHOOL, Muskogee, Ok 74401
127 North "O" Street, Muskogee, Ok 74403

The purpose of my project is to design a low cost, efficient, adaptable Voice Synthesizer to aid in Voice Communication.

Doing extensive research in this area was unproductive. I was able to find only sketchy information relating to my project. Corresponding with the chip manufactories and distributors for the schematics of the speech processing chips was close to futilety, they either ignored or were slow to answer my inquiries. I received one reply after the Regional Fair, and it was to late for the State Fair. Therefore, I had to design the circuit, interface the speech processor to the computer, and write the program code to instruct the speech syntesizer to produce a sound all from scratch.

This project is in it third year of development, during those years I had many failures. I rebuilt my project several times. Numerous problems occured, some were solved by my knowledge, some by trial and error, and some by accident. The most recent and most important(programming the speech processor) was by accident.

At the recent Regional Science Fair my project was based upon the SP0256A-AL2 Speech Processor and was named Gabby I. For the State Fair, I completely redesigned the circuit and used two processors, the ***CTS256A-AL2 CODE TO SPEECH PROCESSOR*** *and the* ***SP0256A-AL2 NARRATOR SPEECH PROCESSOR*** *and renamed my device Gabby II. For the International Science Fair I have changed Gabby II from a ribbon to a card edge connector, redesigned the circuit and used smaller components of the same value which reduced the size of the device.*

#Fourth Award - General Motors ISEF/Engineering

CONTINUOUS MONITORING OF ATMOSPHERIC HUMIDITY BASED ON INFRARED SENSOR INPUT TO COMPUTER

Murali Soundararajan
Blue Valley North High School, Overland Park, KS 66209
11513 Mastin Drive, Overland Park, Kansas 66210

The purpose of this project was to 1) determine the mathematical relationship between the amount of atmospheric humidity and the percentage of infrared radiation reaching the earth and 2) construct a computerized device that would continuously measure atmospheric humidity based on the pre-determined mathematical relationship. The infrared percentage was determined by comparing the computer input from an infrared phototransistor to the total solar output at any given time. This data was correlated to the humidity readings at the times that the infrared data was taken and an equation relating these data was developed. By using this equation, an infrared phototransistor, a phototransistor mount and an Apple IIe computer, a device was constructed to continuously monitor humidity based on infrared transmission through the atmosphere.

THE PORTABLE SOLAR COOKER

Mikulec, Anthony A.
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The purpose of this investigation is to create a solar cooker. This cooker is to have three major qualities: it is to be easily portable, be able to achieve a temperature of 100 degrees C, and be able to store energy (heat) after the sun has gone down. I constructed a lightweight solar cooker that incorporated the basic aspects of earlier designs. I then tested my cooker in the sun several times and made improvements on it as a result of the data obtained in the sun tests. When the cooker fulfilled the above-mentioned purposes, I concluded my investigation. The final version of my cooker can attain a temperature of 132 degrees C in its oven and weighs only 33 pounds. Also, the cooker can continue cooking up to one hour after the sun has gone down.

THE FOLD AWAY EFFECT

Haddock, Jason R.
Mont Harmon Jr. High
865 North 700 East Price, Utah 84501

I created a verticle axis windmill that has H-wing rotors and Teton cloth sails. The sails fold out as centrifugal force increases and pushes the rotors into an H-wing pattern. When the sails fold out they are compacted into a smaller area and the wind has less of an area to push on. As a result the motion of the windmill slows. Eight identical and independent springs control how far the rotors fold out according to wind speed. When the wind speed slows down, the springs pull the rotors back in. It does not matter from which direction the wind is blowing; this revolutionary verticle axis windmill always rotates clockwise because of the shape of the wings. When the wind blows from any direction, it hits a wing and is funnelled to the left, causing it to turn clockwise.

#First Award - Patent and Trademark Office/U.S. Department of Commerce/Patent and Trademark Office Society

#THE NK-708 PHOXX: "FLIGHT TESTING AND ANALYSIS OF TOMORROW'S JET TRAINER"
Nichols, Kent Dean, Salem Senior High, Salem, MO 65560
Rt. 1 Box 191a, Salem, MO 65560

Tomorrow's Advanced Tactical Fighter Program must be supplemented with a Next Generation Trainer. The trainer must provide inherent static and dynamic stability in coordination with unsurpassed aerodynamic tailoring. Short Takeoff and Landing capabilities must be integrated into the aircraft. The trainer must provide a comfortable environment for accelerated learning. The trainer must be adaptable for multiple-role operation in a wide range of applications such as reconnaissance and low-level air support. During the six years of designing an aerodynamic design has emerged. Flight testing has supplemented the previous five years of windtunnel and mathematical designing. An all-lifting fuselage, the trademark of the aircraft, has been developed requiring minimum wing area. As a result, the wingspan was reduced by 37.0%. Shortening of the wingspan reduced spinning inertia, thus decreasing the fatal flat spin. Reduced wingspan and foldable outboard wing panels allow for less deck space on aircraft carriers. The aircraft's lift-to-drag ratio increased by a final factor of 8.72. The canard pitch control arrangement has met the call for a canard equipped trainer. The canard employs positive pitch control. A High-Lift Flap System installed on the inboard wing panels incorporates one of the highest lift coefficients available on a jet trainer. The NK-708's maximum lift coefficient was found to be 2.45. The High-Lift Fuselage System enhances this number by providing 70% of the total lift. Two Garrett F-109 high-bypass-ratio turbofan engines rated at 1,330 pounds of thrust each have thrust vectoring nozzel modifications. This thrust vectoring will increase the pitching torque as well as add air braking. This whole system of flaps, fuselage, thrust vectoring, and short-coupled canard comprise one of the most advanced Short Takeoff and Landing (STOL) systems ever created. This advanced STOL system allows the aircraft to utilize the shortest of runways in the ruggedest of topography. The aircraft has been designed with unsurpassed visibility, despite its unusual fuselage surroundings. The quiet turbofan engines will reduce unnecessary noise, which is very annoying over populated areas. The outcome of these features is the NK-708 PHOXX; a Next Generation Trainer ready to provide training in the safest, quietest, and most stable manner. *PHOXX is copywritten by Kent Dean Nichols 1984.

#First Award - General Motors Corporation
First Award - U.S. Air Force

AN AUTOMATION OF THE HUMAN HAND AND ARM
Proni, Frederick P., Notre Dame H.S., Utica, NY 13502
6 Caryl Blvd., Clinton, NY 13323

The project is a cross between a human hand and arm with a robot which equals a robotic hand and arm. The wrist, fingers, arm, elbow and shoulder can move either right to left or up and down or a swivel movement. They are controlled by a switch (DPDT) which is located in the control box. The power comes from a 9v adapter. All parts and movements can be interfaced with an Apple 2E Computer. The project consists of 347 parts and 365 work hours. My hypothesis was that the project would move faster one way and slower the other way and be difficult to build, because of the weight in the hand. Well, my hypothesis was correct. The reason is that the adapter has low milliamps and has a high power drain. The motors or motions work as follows: the button is turned on, the power travels from the adapter to the switching box, through the switch down the computer wire, it passes through the capacitor and then it moves the motor. All of this happens in 1/27th of a second. The motor moves the gearing in the rotisserie which then turns the axle and moves whatever is on the end of the axle. In the hand, the motor moves a pulley which then moves the fingers. The fingers have two joints and are fully articulated. The main parts of the project are a control box, motors, base, shoulder, arm, fingers and gearings.

A LIQUID-METAL MAGNETOHYDRODYNAMIC POWER GENERATOR

Mar, Kelvin G., Alhambra City H.S., Alhambra, CA 91801
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Magnetohydrodynamic (MHD) power generation is the process of creating electricity from the forced flow of an electroconducting fluid through a magnetic field. The objectives of this project were the verification of basic Liquid-Metal Magnetohydrodynamic (LMMHD) principles in a functioning, laboratory-scale MHD generator implementing liquid mercury as its working fluid, and the optimization of its performance.
The procedure consisted of the design and construction of a functional, lab-scale LMMHD generator, followed by tests of specific variables.
The proposed research is a continuation of a previous project implementing the electrolytic solution saltwater as the working fluid.
Research uncovered polarization effects in the electrolytic conductor, which, in a small device like that studied, limits the amount of power that can be generated. Thus, the use of liquid-mercury, which possesses a conductivity much greater than that of electrolytic solutions, was implemented as the working fluid to help solve some of the previous problems encountered. Tests were completed involving several components of the LMMHD system, but for reasons of safety and the current economic situation involving the project, testing has been brought to a temporary standstill. More research and financial assistance needs to be sought in order for future work on the project to be completed.

LIQUID CRYSTAL ELECTRO-OPTICS

Brown, Brian R., Notre Dame High School
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Liquid crystals are a class of organic substances whose molecules are arrayed in ordered groupings. Ordering can be affected by application of an electric field. Minute scratches on the surface of a container also tends to force molecular alignment.

In my project I set out to design and construct a simple, low cost, electro-optic shutter using the twisted nematic effect; with potential applications to communications and optical instrumentation. Another objective was to gain hands on experience in electro-optic technology. My first discovery was required materials are difficult to come by; and I had to appeal to a research center to obtain them. The shutter is a cell composed of two small squares of glass with a conductive tin oxide coating on one surface and separated by two 0.7 mil Mylar strips. I prepared the glass by a special cleaning procedure followed by a dip in aqueous polyvinyl solution and oven drying. Conductive surfaces were then abraded with a cloth in one direction. In assembly, conductive surfaces were facing and micro scratches oriented either parallel or perpendicular. The cell was clamped in a Lucite fixture and filled with liquid crystal by capillary action. Low voltage DC was applied to the conducting surfaces and the effect on light viewed using crossed polarizers. Quantitative measurements were made with a photoconductive cell.

In conclusion, I successfully developed an operational E-O shutter using LC's. It consumed negligible power and was linear over two distinct regions.

CLUBMASTER: A GOLF SHOT ANALYSER.

BELL, Andrew
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Many Golf Clubs have practice nets, used by players to loosen up or to practice shots, without the need to continually pick up large numbers of golf balls hit into practice grounds. Unfortunately, hitting a ball into a practice net gives the player very little idea of where the ball would have gone, had it been hit down the fairway.

The problem I set myself, was to produce a practice aid which would allow players to practice using golf nets as before, but which would display the type of shot they hit each time.

I did this by securing strain gauges onto the shaft of a golf club in order to measure the deflections that occur when the golf ball is struck. These deflections consist of a bending and a twisting force on the shaft. By examining the variations with time and the maximum values of the forces, it is possible for a computer to determine the distance of the shot and the golf ball's deviation from a straight line. The latter comes about as a result of the spin which the golf club imparts onto the golf ball.

The device can then be set up by the practice net and used by players at will. In addition, the analysis of the reaction of the golf club when it strikes the ball, provides valuable information to golf club manufacturers.

Efficient Speech Model Significantly Reduces Digital Voice Data Rate

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Voice signals are being increasingly encoded by digital, rather than analog, techniques because digital encryption for security purposes is both easier and less vulnerable to unauthorized decryption. The data rate of unprocessed speech is approximately 64,000 bits/s. The data rate, however, must be reduced to 4,800 bits/s or less to transmit digitized speech over narrow-band channels having a bandwidth of 3 KHz or less, such as switched telephone networks. At this low data rate, speech is transmitted in terms of two sets of parameters related to the human speech production model; namely, a set of filter coefficients which represent the resonant characteristics of the vocal tract, and a set of excitation signal parameters which represent the driving function at the vocal cord. Currently, linear predictive coding (LPC) is extensively used for deriving both the filter parameters and the excitation signal (which is the prediction residual). In LPC, the quality of the encoded speech is highly dependent on how well the prediction residual is quantized. In order to generate high-quality speech at 4,800 bits/s, vector quantization (i.e. pattern matching) is applied for encoding the prediction residual. According to the Diagnostic Rhyme Test (a formal listening test), the resultant 4,800 bits/s encoder is as good as previous voice encoders operating at twice the data rate.

#Third Award - General Motors ISEF/Engineering
Honorable Mention - National Aeronautics and Space Administration

# PIEZOELECTRIC FILM AS A REAL-TIME RAIN GAUGE

Ryder, Scott W., Edison Computech High School, Fresno, CA 93706
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Piezoelectric film was used for the first time as a real-time rain gauge that measured the number, size and velocity of water drops. All of this information was obtained by analyzing the width and area of the voltage pulse produced when a drop of water struck the film. The pulse width was a function of the time a drop takes to strike the film. The pulse area was a function of the drop kinetic energy. Both time and kinetic energy can be expressed in terms of drop size (mass) and velocity. The simultaneous equations expressing pulse width and area as a function of size and velocity were solved. The constants of proportionalty were experimentally determined using drops of known size and velocity. Original software was developed which analyzed the digitized film output and calculated the pulse area and width and the corresponding size and velocity. Analysis of a series of drops produced by an irrigation sprinkler resulted in a water delivery rate and a distribution of drop size and velocity. Information from a real-time rain gauge is useful for determining storm type and intensity as well as verifying the performance of irrigation sprinklers.

#Second Award - American Meteorological Society
Second Award - Bureau of Reclamation/U.S. Department of the Interior
Fourth Award - General Motors ISEF/Engineering

# INCREASING SETTLING EFFICIENCY BY A SHEARED VELOCITY FIELD

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This paper presents the theoretical and experimental analysis of the increase in settling efficiency of a sedimentation tank when a sheared velocity field is used. This study assumes that the sheared velocity field produces two phenomena: 1) a lateral force which accelerates the sediment, and 2) an anti-density current which counteracts the density current in the sedimentation tank.

A hydrodynamical approach is used to study the lateral force acting on the sediment. This analysis indicates that the increase in settling efficiency is a function of the product of the flow velocity and the sheared velocity field strength. However, when input parameters from an actual sedimentation tank are used, the increase in efficiency is found to be 1% for coarse sand and only 0.02% for fine sand. Therefore, it is concluded that though the lateral force is theoretically feasible, it is not practical.

Nevertheless, the experimental study shows that the sheared velocity field still produces a significant increase in settling efficiency. This may be explained by the hypothesis that the density current, which decreases the settling efficiency because of the shortened detention time, is nullified by the anti-density current created by the sheared velocity field.

A sheared velocity field generator is constructed and used to analyze the effect of the sheared velocity field on settling efficiency. This study shows that with a sheared velocity field, the efficiency of a sedimentation tank may be increased by as much as 8%. Further increases in efficiency may be achieved by a sheared velocity field generator which does not vibrate as much at the higher speeds.

#Third Award - General Motors ISEF/Engineering

BREAKTHROUGHS IN VISCOSITY MEASUREMENTS MADE BY "THE COMPUTERIZED VISCOMETER" WITH THE USE OF COMPUTER INTERFACING

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"The Computerized Viscometer" is designed to retrieve values like the viscosity coefficient, frictional coefficient, and the fluidity of a liquid by using the falling ball method, several equations--which are derived from the dependence of viscosity on temperature, and a computer for mathematical computation.

When calculating the viscosity properties by using the falling ball method, it is important to measure only the terminal velocity of a falling sphere. Therefore, "The Computerized Viscometer" utilizes an electromagnet to allow the BB to free-fall at terminal speed through the fluid. If excess velocities are measured, the flow tends to be turbulent rather than laminar, which would cause inaccurate data to be obtained.

Since viscosity varies exponentially with temperature, a thermostatic system with great accuracy and control is achieved with a combination of a coffee pot heating unit and two temperature probes. In each equation used to calculate viscosity, temperature is a very important factor; therefore, more accurate temperature readings produce more accurate viscosity results.

Significant improvements in viscosity measurement have been accomplished through the use of "The Computerized Viscometer".

#JAWS IV: 8 BITS TO THE BYTE

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The purpose of my research in the field of robotics, computers, and electronics was to develop a tactile multi-sensor paralleled gripper that was controlled by a closed loop system.

The actual robotic hand and the electronic housing were the mechanical aspects of the project. The brass gripper was the result of many experiments to optimize the size and weight of the hand. The twelve volt motor-gearbox and external gear train were used to optimize the speed and the torque of the gripper. The brass electronic housing was used to separate the individual sensors and to keep them isolated from any unknown objects.

The electrical aspect contained many things. The tactile array consisted of 24 infrared emitters and detectors facing each other to allow a metal strip to block the light according to the pressure applied to it. The heat conductivity probe consisted of a controlled heat element and a heat detector. The external 6502 microprocessor was the heart of the multi-sensored control system, and it "talked" to the Commodore 64 via electronic buffers.

The software for the 6502 allowed it to control robotic motion and read all sensor inputs. The Commodore 64 contained user friendly software and still managed the 6502 efficiently.

The final products of JAWS IV can be used for the sensing of industrial and home robots to identify unknown objects. This project with further research can also apply to bionics or many other unlisted uses.

#First Award - General Motors ISEF/Engineering
Third Award - Society of Manufacturing Engineers

PERPETUAL MOTION (IS IT POSSIBLE?)

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My project attempts to prove the theory of perpetual motion. Since perpetual motion is, in fact, impossible to achieve under its given definition, I have made attempts to construct and test my own original designs of perpetual motion machines. These machines are designed to run on mechanical and physical properties along. These include the use of magnets, counter weights, springs, levers, pulleys, etc. After construction of the initial design, modifications are made as necessary.

None of the devices that I tested proved that a perpetual motion machine can actually be assembled. This is due to a common presence of excessive friction on each model. Dissipative forces such as friction and gravity have prevented any successful trials. If friction could be eliminated or reduced to a minimum, it could be possible to construct a device which would run indefinitely.

# A WELL-BALANCED ROBOT

Jonathan Gray
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I designed and built a two-wheeled robot that keeps its balance. The reason I chose to make a two-wheeled, balancing robot was that I had never seen one before. I believed that it could be done, and I wanted to prove it. I believed that it would have many practical uses in the fields of military and transportation.

I had to deal with the problems of detecting the balance of the robot, calculating how to regain the balance, and regaining the balance. To detect the balance loss, I used a light detector and a stationary light. To get this data to a computer, I used an analog to digital converter and a special communications device that used RS-232. To regain the balance, I used an SCR drive and a DC motor.

#Fourth Award - General Motors ISEF/Engineering

#ENGINEERING CALENDERED CELLULOSE PRODUCTS FROM WASTE MATERIALS

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The hypothesis of this project is Can a quality paper product be made from waste materials? The materials used to reach the conclusion were papers made from hay, rye straw, computer paper, peanut hulls, oats, cornstalks, newsprint, cardboard, sugarcane, sawdust, cotton waste and a commercially made paper. Four procedures were involved in this project. The first procedure was the making of the papers. The second procedure was the seven tests given to each paper for: Memory, Flexibility, Absorption, Tensil Strength, Burst Strength, Flammability and pH. Each paper was tested three times then an average score noted and graphs were made for clarity. The third procedure was to use the finished papers to make the products. The fourth procedure is an investigation as to the feasibility of using waste materials for the development of cellulose products as to that of wood fibers. The investigation is in its preliminary stages. Results of this investigation will be finalized when sufficient amounts of credible data is accumulated.

#First Award - Sigma Xi, The Scientific Research Society

#ROBOTIC EXPERIMENTATION

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The purpose of my project was to construct an intelligent, mobile type of robot capable of simulating basic human functions. The ultimate goal was to create a robot that was human-like in appearance so that it could interact with people. This would be the basis for a personal robot that would operate in a home environment.

The robot is driven by two base motors. This provides front, back, left, and right motion. The body section of the robot rotates left and right. Up and down elbow action and the opening and closing of the end-effector are also possible.

The robot's mobility along with the aid of its manipulator and end-effector allow it to perform many useful functions. The robot can be controlled to carry out these functions either manually, through human intervention, or by computer. It is equipped with a computer, monitor, and disk drive. The monitor displays a computer-generated face which makes the robot appear more human-like and less threatening. Through the use of the computer it is possible to program software to adapt to different needs and situations. Other software for the robot includes an intermediate mode of control, and a program mode, which can be programmed in robot control language. However, the computer can still be operated normally, so one can use it wherever it is convenient, due to the robot's mobility.

#Second Award - Institute of Electrical and Electronics Engineers

HYDRODYNAMIC COMPARISONS OF UNDERWATER LIFTING SURFACE CONFIGURATIONS

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In 1983, the racing sailboat design world was turned upside-down quite literally, by a racing boat called Australia II, sporting an underwater surface configuration unlike anything before. Since then, many new shapes and configurations of keels have been developed. This project developed and tested underwater lifting surface configurations from the two major design rules today, the 12 Meter Rule, and the International Offshore Rule. In addition, one keel was developed by the author using research and ideas from both rules. These foils (6) were carefully constructed,keeping a constant draft, volume, surface friction, and section shape. A test tank was built,using an electric motor and milliammeter to measure the drag. Each foil was then towed in the test tank at 3 different angles of attack (0, 17, 90) 5 times, recording the milliammeter reading on each run. A mean was computed from this data (in milliamps), and these figures were used to creat a Velocity Prediction Program for the computer, which 'raced' the keels against one another on a simulated real-life Olympic racecourse. Then each keel was ranked (1 to 6) in each category (lift,drag, L/D, & VPP), and the average placement was computed. The lowest average placing keel was the best overall. The keel developed by the author was ranked first. In addition, graphs were made and studied to determine how design features relate to test performance. It was found that inverse planform creates a significant loss of drag, that inverse section loading works much better than elliptical loading, and that winglets do seem to help overall. This project allows a much better understanding of what configuration features perform better on underwater lifting surfaces, and provides insight into keel shapes for the future.

REFRIGERATION CYCLE USING SOLAR ENERGY AND HEAT OF SOLUTION OF AMMONIUM CHLORIDE

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The typical refrigeration system operates on the cooling principle of the vaporization of liquid and the expansion of the vapor. Electrical energy is used in a compressor which turns the cooled vapor back into a liquid to be recycled in the system.

In some parts of the world, refrigeration for medicine and food is not available because either electricity is not available, or the compressor system is too complicated. If a system could be developed which uses solar energy and does not use precision machinery, gases, or electricity, underdeveloped nations could raise the quality of life for its people.

Many other physical and chemical processes can absorb heat other than the expansion of gases. For example some salts, when dissolved in water, absorb heat and cause the temperature of the solution to drop. If a salt, with a positive Heat of Solution, could produce "cold", the resulting solution could be used to provide a primative form of refrigeration. With sufficient solar energy, the solution could be evaporated in order to reclaim the salt to be redissolved and produce further refrigeration creating a continuous refrigeration loop.

For my project, ammonium chloride was tested in a calorimeter to measure its cooling effect and temperatures down to 3°C were reached at saturation. A two-stage system was tested which reached -9.5°C. The saturated solution was evaporated with a heat lamp and the reclaimed salt was redissolved and tested with similar results.

The experiments proved that combining a salt with a positive Heat of Solution, and a solar powered salt reclamation cycle could produce a workable refrigerator. In order to prove the practicality of the process, a "proof of concept" model was constructed. The model shows that the system works. Advanced designs and ideas for further research are presented.

A GAS CHROMATOGRAPHIC STUDY OF ALCOHOL ADDITIVES

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Hydrocarbon fuels exist in a finite supply, and one method of prolonging and enhancing this limited resource is through the use of additives to improve fuel performance. This experiment, a culmination of a three year project, was aimed at exploring the effects of molecular structures in alcohol additives on fuel performance. Specifically, it was intended to explain how combinations of straight chain alcohols and branched chain alcohols produce a synergistic effect on fuel performance.

Combinations of butanol alcohols, which exist in structural isomers exhibiting branched and straight chain structure, were used as alcohol additives and combusted in a model airplane engine. The resulting exhaust gasses were then analyzed in a gas chromatograph. Test fuels containing branched chain alcohol additives exhibited more complete combustion. It is theorized, then, that the action of the branched chain additives producing more complete combustion contributes to their observed synergistic effect on fuel performance.

This project further enhances the extent to which the action of alcohol additives is understood. A greater understanding of the actions of fuel additives will ultimately lead to the production of better fuels in a faster and more efficient manner.

#First Award - General Motors Corporation
Alternate - U.S. Department of Energy

TAKING A "BYTE" OUT OF CRIME

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The purpose of my project was to develop a user friendly video imput security system specifically designed for the small businessman. This system utilizes the business computer during non-business hours. Also, during the business hours, it is possible to operate the program on the computer without a significant slow down in the computer's operation.

My copyrighted self-written security program makes video image comparisons every 10-15 seconds. This kind of speed results from the use of 65C816 assembly language in conjunction with an Apple IIGS having a 1.256 megabyte business memory. The entire program stores on a single 3 1/2" disk.

Additional system hardware required is a basic (bottom of the line) b/w video camera and a ComputerEyes/2 card, a type of video digitizer which interfaces the camera image with the computer storage capabilities.

Features of this system are single and multiroom surveillance, protection from unauthorized tampering and one key activation with automatic calling of an emergency number should a security breach occur. My "Security Plus" system is versatile with many user options which include the ability to adapt to previously installed security systems and adaptation to a color camera. Should a security breach occur one could choose to study a 35 picture recall or a VCR tape which was activated at the time of the security breach.

Further versatility is demonstrated in the ability of the system to be set up by non-technical people using minimum time, allowing new areas to be secured in an efficient and effective manner. My system program design allows for a tripod mounted camera and allows for a slight movement of the camera or secured object thus minimizing false activation of the alarm. This in turn would eliminate unnecessary and frustrating investigations by law enforcement officials.

#Third Award - General Motors ISEF/Engineering

IMPROVING AIR FLOW UNIFORMITY IN A LUMBER PREDRYER

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The problem presented with this project is: How does one get efficient air flow in a lumber predryer? The theory for this project is: Adding more baffles to the predryer and improving their placement will help improve air flow. Since air takes the largest path of least resistance, baffling would redirect air into the stacks instead of straight down to the floor.

The experiment began by measuring air flow with the existing baffles in a predryer. The existing configuration was one fiberglass baffle at eight feet six inches from the floor. It was then decided to use six layers of baffles and five different configurations. These were tested.

It was noted that the top of the top bunk was still not getting enough air flow, so another layer was added, making seven layers, and testing began again. There was a noticeable difference with the added seventh layer at the top. These configurations were tested. There were fourteen different configurations to test.

The configuration that worked the best had more baffles at the top and fewer at the bottom. This was because the top layers needed more air than the bottom.

The conclusion is that the baffles helped improve air flow uniformity in the predryer. Thus, more baffles, properly placed, would save money by reducing the time required for lumber to stay in the predryer.

# DIFFRACTION STUDY OF ERYTHROCYTE COMPOSITION BY COMPUTER CONTROLLED HeNe LASER SCANNER LS-3 SYSTEM: PHASE 4

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This phase of the LS-3 System involves construction of a multipurpose optical scanner for classifying microstructures. The problem has four components: Do erythrocytes have distinctive diffraction patterns recognizable above background noise? Can the patterns be quantified? Is there consistency in diffraction patterns of erythrocytes from the same donor? And, are the patterns unique to the individual donor or to a blood group?

The procedure for this phase consisted of 2 parts: the construction of the third generation LS-3 System, and the development of a mathematical correlation between the components of a 3 dimensional structure and its corresponding 2 dimensional diffraction pattern. First, the laser scanning system was designed so that all parts became stationary on a horizontal plane to eliminate the effect of gravitic strain on the stepping motors. The laser was affixed upside down to the inside top of the casing and the beam angled downward. In this way, the motors move the phototransistor in an "X" and "Y" plane on a horizontal surface with an adjustable resolution ranging from 150 by 150 points of data (p.o.d.) to 400 by 500 p.o.d. in a total scanning area of 10 by 10 inches. The scanning motors are computer operated and the presence of light is read through an input port as either a "1" or a "0". Once digitized, the patterns were then transmitted into a sequencial file for later analysis. The theory and mathematical derivation used in studying the specimen structure is based on Huygenes Principle of Diffraction and some basic calculus applied to spatial differentation. The resulting analysis gives rise to these values per pattern: a calculated geometric center, a geometric radius, a center of mass, centers of mass outside the standard geometric radius (lobes), and polar coordinates of these centers including angle-to-angle ratios. Files with patterns of clear slides and the laser alone were taken into account as noise and subtracted.

Some consistency between cells from the same donor have been quantified and standardized. The next step will involve determining whether these consistent patterns are unique only to that particular donor or they do in fact remain consistent to other donors of the same blood group.

#First Award - U.S. Army
Second Award - General Motors ISEF/Engineering
Honorable Mention - Optical Society of America

#DEVELOPMENT OF THE GUTZEIT/REINER METHOD FOR ARSENIC TRIOXIDE DETERMINATION IN THE FIELD

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2630 San Juan Capistrano - Sierra Vista, Arizona 85635

The initial research of this project was completed at the University of Hawaii at Hilo this last summer. In Hawaii, I observed Dr. Kho's research on the toxic compound arsenic trioxide present in water samples from Hilo Bay and the Wailoa river. The very sensitive and complex method of atomic absorption was utilized to determine the amount of arsenic present in the water samples. After working with Dr. Kho for a week, I became interested in the extent of arsenic trioxide pollution in the water of Arizona. However, it became apparent that the atomic absorption method was not practical for my research in Arizona, since none of the labs in Sierra Vista were equipped with an atomic absorption system that I could use. The rest of my research time in Hawaii was spent testing the Gutzeit method, an alternate method of arsenic determination, for accuracy. While the results obtained from the Gutzeit method provided a precise way of determining arsenic concentrations, I was concerned about the possible danger of arsine poisoning in the lab. Back in Arizona, my research developed the non-toxic Gutziet/Reiner field test method by modifying the already existing Gutzeit procedure. In my project, three tests were performed with only the last one yielding successful results. In that test, I determined that a solution of silver nitrate would capture the arsine produced by the Gutziet method. My research has provided a way to test for arsenic using a safe and portable field device.

#Second Award - American Water Works Association

#WHITE LIGHTNING: A SAIL-POWERED HYDROFOIL

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Most of the world's sail-powered hydrofoils have the conventional airplane configuration of foils, with the majority of the weight on the front foil. Through repeated testing with prototypes, my design evolved into a canard wing configuration. The advantages of this configuration come from placing the weight of the boat aft, with the rear foil supporting most of the boat's weight. With both sail and weight at the rear, the hulls hydroplane more easily. In my design, flat hulls assist this hydroplaning.

My radio-controlled model measures 2'by2', with a solid airplane wing mono-sail 32" high. The four functions that can be controlled are rudder, front foilpitch, sail control and lateral weight distribution. The mono-keel (a keel that doubles as a rudder), coupled with the mono-sail, gives the boat a high hydrodynamic efficiency. The rear foil is a shallow bow shape. The front foil is deeply arched and tension-mounted for strength.

As for cost of construction, a flat hull is less expensive to build than a contoured one. Curved foils are inherently strong and light yet efficient. The aluminum foils of this model would be too weak for a full sized boat, but a relatively inexpensive alluminum alloy would suffice. A marketable version of WHITE LIGHTNING would have a narrower deck and a nylon sail. Though a high performance boat, it might cost no more to build than a conventional catamaran.

#Scholarship - U.S. Navy
Honorable Mention - American Intellectual Property Law Association

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THE HONEYCOMB VS. THE CUBE

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The purpose of this project is to make a comparison between the ratio (volume/surface area) of a honeycomb and a cube.

The most common building design found today is the cube or some form of it. For thousands of years, honeybees have been using the honeycomb for storage and living quarters. Since most technological devices are crude representations of biological adaptations, I assumed that the honeybee would have the most efficient use of materials.

My project helped determine whether the honeycomb or the cube was the most material efficient (more volume for the same amount of surface area).

First I constructed a honeycomb and found the surface area of it. Then I constructed a cube with the same surface area. Second, I found the volume of both the honeycomb and the cube, and compared their ratio (volume/surface area).

I found the honeycomb to have more volume for a equal amount of surface area.

Thus the honeycomb would be an important design for architectual engineering in the future. It may even extend its usefulness into space station design.

# MICROPROCESSOR TECHNOLOGY

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This project consists of the development and the application of a computer system to control the sixteen inch Newtonian telescope at the Black River Observatory. The telescope is one of high quality, but it is severely limited because it cannot accurately track targets. This project will expand the capabilities of the telescope not only to track targets, but also to allow the many capabilities that a high performance computer can provide, and was done by designing, constructing, troubleshooting, and programming the system. Based on the 68000 microprocessor from Motorola, the computer is completely operational and has been extensively tested for endurance, noise immunity, component heating, etc., and has passed all tests with perfect results. The telescope interface is in the process of being wired, and the drive for the right ascension axis has been completed. The drive for the declination axis is in the preliminary stages of construction. The monitor program required for system operation has been partially completed, and there has been steady progress towards its completion. The program is at a level where keyboard commands are recognized and executed as determined by the operating system. Of course, the programs required to control the telescope await the completion of the interface. In short, the computer is working perfectly and will support the telescope drive as planned.

#First Award - Institute of Electrical and Electronics Engineers
Third Award - General Motors ISEF/Engineering

THE GAUSS RIFLE: FICTION OR REALITY?

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Until recently, new and innovative ways of using magnetism in a practical sense have been limited to motors, compasses, recorders, etc... The advent of the computer, the development of the Strategic Defense Initiative, and planned outer space mining have opened new avenues for applying magnetism in a practical sense.

The development of the Gauss rifle was based on a fictional description found in "Traveller," a role playing game. It describes a Gauss rifle as a magnetic gun. That is essentially what I have developed.

By using a digital sequencer, mechanical relays, and multiple staged solenoids, I was able to accelerate projectiles up to mean velocities of 5.25 m/sec.

The second generation of the Gauss rifle had many major design changes. The sequencer was modified to utilize solid-state switching devices. These devices reduced the mechanical time lag caused by the action of the relays and as a result, increased projectile velocity. The solenoids were replaced by electromagnet "banks." Each bank contained four electromagnets arranged around the barrel like spokes on a wheel. This change prevented the projectile from backfiring and reduced the total current load on the system.

The third generation of the Gauss rifle will utilize a dependent sequencing system rather than the independent ones found in the first two generations of the rifle.

The design changes and test data led to the conclusion that a Gauss rifle can be used effectively for projectile transport.

#Fourth Award - General Motors ISEF/Engineering

PASSIVE COOLING WITH CONTROLLED SURFACE CONDUCTANCE, A CONCEPTIONAL STUDY

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In this project the potential use of controlled surface conductance is explored for the purpose of passive cooling. The study was strictly conceptional.

It was demonstrated that the heat loss through glass windows is almost entirely controlled by surface conductance, a radiation related phenomenon.

The fact that the density difference across an interface dictates surface conductance lead to the idea to change temporarily the density in the space between the two panes of double pane windows, by filling it with water.

In order to show that the difference in surface conductance between an air-glass and water-glass interface can be used to control the heat flux into and out of a house, a conceptional computer model was developed. It consisted of: a double pane window, a room, and an energy storage mass. Six experiments were performed with the model: uncontrolled surface conductance (air in space between panes), controlled surface conductance (water or air in space between panes), variation of the time at which the water was drained, variation of storage capacity, variation of the conductance from the room to the storage mass, and variation of the amplitude of the outside temperature fluctuations. Two main conclusions were derived from the study:

1. It is possible to control surface conductance by filling water into or draining it from the space between the panes.
2. Careful selection of the main parameters will permit to achieve a passive cooling effect.

# CONSTRUCTION OF AN INEXPENSIVE ULTRAVIOLET NITROGEN GAS LASER

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The laser is one of the most dynamic inventions of our time. The monochromatic coherent beam of light emitted by this device has come to have many uses in the areas of industry, medicine, engineering and defense. The purpose of this project was to construct an inexpensive nitrogen gas laser that pulsates in the ultraviolet region of the spectrum. This type of laser was chosen because of various advantages it offers. First, nitrogen gas can be extracted from air, thereby eliminating a portion of the total expenditure. Also, nitrogen atoms lase easily without the need for very high voltages or an optical cavity. Furthermore, this laser emits a 10 nanosecond pulse of ultraviolet laser light (337.1 nm) which makes it very useful for high-speed photography, rangefinding and as a pump for dye lasers. The construction procedure consisted of building a high voltage power supply that ran off 110 volts a.c, using a step-up transformer and voltage multiplying rectifier to deliver 12 kV. A nitrogen gas supply that removed oxygen, carbon dioxide and water vapor from the air was made. The Blumlein switching mechanism was used in construction of the discharge gap to enable sudden electrical discharge through a column of nitrogen gas at 13.3 kiloPascals pressure. It is this discharge that begins lasing action. The cost of this project was a small fraction of the cost of a similar laser on the market.

#Second Award - Optical Society of America

#DESIGN REQUIREMENTS FOR STABILITY IN MODEL ROCKETS

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According to theory, the center of pressure (CP) of a rocket must be behind the rocket's center of gravity (CG) in order for the rocket to fly with stability. Using a wind tunnel to fly test models, this project tests this theory. It also tests the effect on stability when the two centers are further apart or closer together. Experimental test flights were made in the wind tunnel with varying relationships between the center of pressure and the center of gravity. To compare differing degrees of stability, the rockets were diverted from their lines of flight a known degree and were timed as to the amount of time they took to return to normal flight. The times taken in repeated trials were averaged to get reliable results. Then stability curves were derived, plotting average time of return against the distance between the centers of gravity and pressure. The best position for the center of gravity relative to the center of pressure was determined, using units based on the total two-dimensional surface area of the rocket. It was also learned that the center of gravity may not be located behind the center of pressure because the rocket loses its ability to correct itself in flight when disturbed.

#Third Award - American Astronautical Society
Honorable Mention - National Aeronautics and Space Administration

#ARE DIAMONDS A PLANE'S BEST FRIEND?

Clint Rhoden
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An experiment was done to determine if a diamond shaped or joined-wing airfoil could be designed and constructed that was half the length of a conventional wing but with the same lift ratio. A diamond shaped wing was chosen for the experiment. The diamond shaped wing was chosen because of three basic advantages over the conventional wing. The diamond shaped wing had greater structural strength. It added direct left or right movement without banking left or right, and up or down movement without pitching the airplane up or down. It reduced wing span which results in cheaper operation of the airplane. The dimensions of a diamond wing with the same lift ratio and half the length of the conventional wing were calculated mathematically. A model of each wing was constructed. A wind tunnel consisting of a blower fan, honey-comb, lift balance, and actual wind tunnel was then constructed in order to test the wings. Each wing was tested in the wind tunnel by measuring the time it took the wing to reach the maximum point in the tunnel. The data was compiled and put into a graph comparing the effectiveness of both air foil designs. The conclusion was that a diamond wing could be constructed for the same performance as the conventional wing.

#First Award - International Aerospace Hall of Fame
Honorable Mention - Federal Aviation Administration

# "PROPELLER DYNAMICS"

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ABSTRACT:

This project involving dynamic forces was conceived to test a new type of propeller designed to vary its pitch angle by torsional flexing of the blades in a planned manner proportional to load. To prove the idea was feasible a vertical wind tunnel was designed and built. A variable speed drive was installed to turn the prototype propeller inside the tunnel air stream. To determine the efficiency of the propeller, considerable instrumentation had to be developed. Tunnel air speed, temperature and barometric pressure had to be measured. Also, propeller thrust,torque,rotational speed and pitch angle had to be measured while the propeller was rotating. Special thrust, torque, and pitch gauges were designed and built which could be read while illuminated by a stroboscopic light triggered by a spark system. Three tachometer systems, two torque gauges, two air speed indicators and three propeller designs had to be developed because of problems with the first designs. An invention disclosure was filed with the U.S. Patent Office on the propeller design that was developed.

#First Award - BDM Corporation
First Award - Federal Aviation Administration
First Award - General Motors Corporation
First Award - General Motors ISEF/Engineering
First Award - National Aeronautics and Space Administration
First Award - Rockwell International
First Award - U.S. Department of Energy
Second Award - International Aerospace Hall of Fame
London International Youth Science Fortnight Trip - U.S. Navy
Alternate to Glenn T. Seaborg Nobel Prize Visit Award

Determining The Aerodynamic Efficiency of Specific Automobile Designs

Matthew Mast
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This project was performed to determine the most efficient shape for automobiles. Aerodynamics is a very important consideration for automobiles. It is a big factor in fuel consumption, and affects: road noise, handling, traction, and appearance.

The basic automobile design was tested in eight different areas: front end (top and side), fender skirts, trunkline, bodysides, tail, underbody, and grill efficiency. Sets of scale models were constructed of ultralight styrofoam to test each area. A wind tunnel was made of 3/4 inch plywood, and powered by a 1/5 horsepower blower. The models were placed on a rolling platform in the tunnel and were tested by the distance the wind moved them. The platform was anchored with a rubber band for resistance.

After all models were tested, it was generally shown that a smooth, well rounded body was the most aerodynamic. Body cavities like wheel wells, a grill, and an uneven underside detracted from the aerodynmic quality of the automobile.

After all tests were complete and conclusions reached, a composite model was constructed in relative 1/24 scale. This was tested against a scale replica of a standard passenger sedan. The composite car demonstrated superior aerodynamic characteristics and thus further supported the conclusion.

# THE SCIENCE OF BIONICS

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Bionics (bio-life, ics - electronics) is the study of how living tissues and electronics can function together to produce working prothetic devices. Normally, teams of biologists, physicians, engineers and computer specialists work together to design, construct and put in place prothetic devices. These devices can then take a myographic impulse from the brain and transfer it to microcomputers which in turn regulate a series of motors that do specific tasks.

The author of this project used the ideas above in an attempt to design a functioning, model bionic arm that uses modern electronic components. The components used in the construction cost about ninety dollars and were salvaged, over the past five years, from a variety of electronic devices and other common materials. For example, in the arm constructed, fishline was used for ligaments, stereo motors for muscles, wood for bone, plastic for skin and an eight track stereo for a movement control center.

The arm itself can be controlled manually, by pushbutton or by infrared beams. So in practice, the arm can turn itself on when an infrared beam between the thumb and finger is broken. It is then regulated by an eight track stereo system and an integrated circuit which supplies pulses to change the tracks, and in turn, the arm's movements.

In addition, an infrared hand-simulator was designed and built. The simulator uses infrared beams to monitor the experimentors hand movements and in turn duplicates the actions on the model bionic arm.

In conclusion, it was found that a low cost model bionic arm could be constructed that displays many of the functions of a "true" bionic arm.

#Third Award - Ball Corporation
Third Award - General Motors ISEF/Engineering

USING A COMPUTER FOR MONITORING AND CONTROL

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The purpose of my project is to demonstrate the use of a computer for monitoring and controlling external devices. I have demonstrated the principle of monitoring through the use of a thermistor and an RC oscillator. The computer was calibrated to interpret various frequencies from the oscillator as various temperatures. Thus, the computer was like a thermometer, monitoring temperature.

To demonstrate control, I switched on and off a lightbulb by using the computer. I then developed a simple heat-control system using the lightbulb as a heater and the thermistor as a heat probe. The system is designed to keep itself near in temperature to the set point or desired temperature.

I also developed a more elaborate system using the same thermistor circuit and controlling a hot plate with the computer. I kept a water bath at constant temperature. I then placed an Oswald viscometer in the water bath and in using a laser and light-sensitive resistors, I determined the flow time of water at different temperatures through the viscometer. This flow time is a measure of viscosity.

#MAXIMIZATION OF PERFORMANCE IN A COAXIAL PULSED INDUCTION ACCELERATOR

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A coaxial pulsed induction accelerator (CPIA) utilizes electromagnetic coils to propel a projectile. Phase I of this project involved the design and construction of a working coil gun magnetic accelerator. It was limited in its output kinetic energy because of mechanical limitations in the magnetic acceleration. Therefore, it was the purpose of this project to determine the mechanics of magnetic acceleration and to maximize the output kinetic energy attained by a projectile in a CPIA. It was hypothesized that in the CPIA the projectile has solenoidal motion and is accelerated until it reaches the center of the magnetic field; then, it is decelerated to output velocity. Higher output kinetic energy can be achieved by altering the mechanics of acceleration.

In the Phase I demonstrator one acceleration stage had an output velocity of 12.4 m/s. In this project the velocity was improved to 17.97 m/s by optimizing capacitance and increasing voltage. Next, a chopper shunt circuit was designed and constructed. The chopper decreased deceleration by diverting energy into a second coil at a predetermined time delay. The addition of third and fourth coils at set time delays increased velocity to 27.9 m/s, an improvement of single state output kinetic energy of 403%. Testing was conducted to determine displacement versus time of the projectile motion to understand the mechanics of acceleration. The results showed that further limiting negative acceleration will increase output kinetic energy.

#First Award - U.S. Navy
Second Award - U.S. Air Force
Third Award - General Motors ISEF/Engineering

SUTURES: A STUDY OF TENSILE STRENGTH

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Modern surgery is based on the ability to control bleeding and close incisions. Usually sutures, strands of material used to join together the edges of an incision or wound by stitching, are used. Several factors influence the type of suture material used in each surgery, including the loss of tensile strength through absorption into surrounding tissue. Suture materials are classified either as absorbable or nonabsorbable. By soaking suture strands of natural and synthetic materials in body fluids with certain pH levels for specific lengths of time, one can determine how the pH of the surrounding tissue and fluids found in internal organs affects the tensile strength lost by a suture strand when actually in a human body. Tensile strength can be tested using a specially designed machine based on a pulley system and a torque wrench to measure how much force is needed to break a specific suture strand. Nonabsorbable suture materials should not lose any tensile strength after being soaked. Absorbable materials should lose a certain amount of tensile strength depending on the pH of the solution the strand was soaked in, and the amount of time the strand was soaked. In my experiments, I found that nonabsorbable suture materials did not lose any tensile strength. The absorbable suture materials lost a certain amount of tensile strength, but the amount lost did not vary according to the pH of the body fluid.

SOLAR CELL ARRAY EFFICIENCY WITH VARYING CURVATURES, ORIENTATION AND MIRRORS

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To find efficiency (eff.) of a solar cell array, tests were done in tracking (array remains perpendicular to sun) & non-tracking (array remains stationary). The project purpose was to find the most efficient solar panel or shape. In all tests, a 300 watt light bulb was held over a flexible array and tested for wattage output. Non-tracking Questions: 1.Which solar panel angle is most efficient? 2.What is the most efficient angle to place a mirror against a panel? Sun angles for 11 hours of 4 days were found. 432 tests were made at every sun angle for panel angles of 22.5°, 45°, & 67.5° and mirror angles of 30°, 60°, & 90°. Efficiencies were averaged and graphed to find the best panel or mirror angle for each sun angle and day.

Conclusions: The best angle of a panel for any given place is the latitude of that place. If one starts on day 79 with a panel angle the same as the latitude, and changes the angle 2° per week, decreasing after day 356 and increasing after day 172, the approximate most efficient angle will be obtained every day. The best angle to place a mirror decreases as the latitude increases.

Tracking Questions: 1.What is the most efficient concave shape? 2.Which mirror angle will make a flat solar array more efficient? Three shapes were built. The eff. of each was determined and from the efficiencies, the best concave shape found. The best shape: .105% eff., depth of 7.5cm, & curvature length of 43cm. A mirror was placed against a panel at angles of 45°, 90°, & 135°. Eff. at each angle was found and graphed. Best mirror angle was determined. Best angle= 101.5, .127% eff. Tracking Conclusions: Concave shape is not needed. Flat shape with mirrors is better. Four mirrors would improve eff. over use of one.

SOLAR COLLECTORS: EFFICIENCY AND HEAT STORAGE TANKS

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Solar collectors are a promising consideration for energy conservation. They offer a variety of options for homes and industries. They are ideal for saving money on hot water heater bills and can also be used to heat or cool a home or business. A solar collector was constructed to examine factors affecting the efficiency of solar collectors. This 2½ year study consists of three main different experiments to determine methods of getting the highest efficiency possible. (1) The construction of the collector itself producing the efficiency of 63%. (2) It was followed in determining the most efficient liquid conductor in the tubing which was found to be a 50% anti-freeze solution. (3) The third and final stage of the project involved the study of heat storage. The following substances were tested: copper, glass, granite, steel, quartz, and water. As an end result, it was found that water is the best heat storage material.

#COMPUTER-CONTROLLED WEATHER SATELLITE STATION

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Research was conducted to design and construct an inexpensive computer controlled weather satellite station that will produce pictures equal to those from government and commercial installations which cost tens or hundreds of times as much. Simple basic equipment found in a local Radio Shack, hardware store and other electronics outlets was used to construct a computer-controlled facsimile system for the direct-printing of weather satellite picture transmissions from the United States TIROS-N/NOAA and Russian Meteor series of weather satellites. The direct-printout medium used provided a print directly without the need for paper processing or darkroom operations. The computer programs that were written and the hardware interfaces that were designed and built work cooperatively in performing such functions as locating and tracking polar orbiting weather satellites, turning the receiver and recorder on and off at the proper times, and analyzing cloud patterns in weather satellite pictures.

#First Award - National Aeronautics and Space Administration
Second Award - Patent and Trademark Office/U.S. Department of Commerce/
Patent and Trademark Office Society
Fourth Award - General Motors ISEF/Engineering
Honorable Mention - American Meteorological Society

#INNOVATIVE CAM ENGINE DESIGN AND TESTING

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The purpose of this research was to develop an improved reciprocating piston engine as an alternative to the conventional crankshaft design. The engine consisted of a cycloidal cam with a piston and connecting rod roller follower. A supporting member minimised side forces against the piston. Flexible system timing inherent with cams enabled torque and piston timing optimisation. A longer combustion period could potentially improve combustion.

In the first phase of this investigation, several engine cycles were evaluated and the engine operating theory was developed. The effects of several exhaust recovery methods on the thermal efficiency were examined. A unique reheat cycle scheme theoretically yielded major efficiency gains of 25-45%. Engine torque was also calculated and showed a 170% improvement.

During the second phase, a single-cylinder prototype was designed and tested to demonstrate the cam concept. The prototype was a modified four-stroke spark ignition Briggs and Stratton engine. In the third phase, the design was mechanically improved and the engine was adapted for two-stroke operation. More sophisticated testing and computerised monitoring were employed. The working model showed the potential for developing a full-scale engine.

#First Award - General Motors Corporation
First Award - General Motors ISEF/Engineering
First Award - Society of Women Engineers
Second Award - Rockwell International

THE CLIMBING WHEELCHAIR

McFarland, Ryan Joseph
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My high school does not have an evevator or any other type of mechanical lift for transportation from one floor to another. Therefore, there is no way for handicapped persons to attend classes anywhere except the main floor unless they are manually carried from one level to the next. After several teachers expressed concern for the safety of these special students and the possibility of causing unintentional harm to them, our school board investigated the feasibility of a wheelchair lift. This device, which attached to the stairwell wall, would cost $50,000. I decided there had to be a better way and set out to develop a self-contained wheelchair that could solve the problem of navigating stairs. My design had to be narrow enough to fit through standard doorways, light enough to be manually rolled on relatively flat surfaces, and balanced well enough to safely ascend or descend a 2/3 slope flight of stairs. My prototype not only accomplishes these objectives, but it also is capable of traversing sand and grass hills, gravel, curbs, ramps, and even snowdrifts. I am currently trying to register a patent on my idea, although I am still refining and improving it. I am developing such ideas as a two track system, hydraulic track lifts, geometrically shaped frame, and a fully motorized chair. In the future, I plan to be involved in the evolution of the ultimate wheelchair design.

#First Award - Junior Engineering Technical Society
Fourth Award - General Motors ISEF/Engineering

#Computer Assisted Hydrodynamics: Turbulence Effects on Foils

Nash, Jonathan
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Desiring to make high precision observations of foil coefficients and flow patterns, I designed a computer and video assisted water tunnel. By storing water in a large holding tank and releasing it in a short 'flush', a high power flow resulted, creating an ideal atmosphere in which to test foils' performance. Two objectives evolved through experimentation with the hydrotunnel: to link turbulence with lift and drag forces; and to develop computer simulations of fluid flow and foil coefficients. Forces on the foils were measured by computer, while the fluid flow around different shapes was observed by injecting dye into the stream and recording the flow patterns on video. From this data, a computer simulation program was created to predict the fluid flow around any object. A system of axioms were developed from the analization of the fluid flow, and in conjunction with choatic mathematical interation processes, this information was programmed to simulate flow around any similar object, oriented in any position. Information was also gathered about dimpled and smooth foils, and it was determined that roughening a foil creates a turbulent boundary layer, which being thinner than a laminar one, has less drag than its smooth counterpart.

#First Award - U.S. Department of Energy
Second Award - Federal Aviation Administration
Honorable Mention - Eastman Kodak Company
Honorable Mention - National Aeronautics and Space Administration

"SOUND OFF"

Rheinhardt, Keith C.
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Hypothesis: The ceiling and wall material that has the largest density value will be the most sound resistant. First I calculated the density, $d=m/v$, of the seven materials I planned to use in my testing. I constructed a working sound source which consisted of a Casio keyboard, which gave me a G note at three octaves. In order to amplify the keyboard, I had to connect it with a 50 watt amplifier. This set-up provided sufficient volume for my testing. I also constructed a sound measuring compartment which was to be used with a sound level meter (measures sound in decibels). This meter acted as the source of data for my project. As the sound passed through one of the materials being tested, the meter picked up the amount of sound, in decibels, that passed through the material. This enabled me to rank the materials in order of sound resistance, the lowest decibel reading placing first, next lowest placing second, and so on. I found in contrast to my hypothesis that density has little to do with a material's resistance to sound. After careful observation of the patterns of my results, I concluded that the materials were presenting me with two variables which accounted for the conflict between my hypothesis and results. These variables were the material's surface make-up and its inner composition. Therefore, I must conclude that sound resistance also depends on a material's surface make-up and its inner composition.

#THE WINDSCOOP A NEW FORM OF VENTILATION

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Because of the economic factor in Puerto Rico most neighborhood houses have been built in the same way, very close together with an average ceiling of 8 1/2 ft. high, and with materials that retain a great amount of heat, these are the 3 main factors that contribute to poor ventilation in these houses. For this I designed the windscoop, which is a new form of ventilation which will help reduce the high temperatures in these houses.

After studying the problem a design was reached, then tested through five different experiments to see the effectiveness of these, which proved correct to the hypothesis.

The design consist of two funnel like apparatus which go on the structure. The front scoop would be used to let the lower temperature air to come in from outside, and the back scoop would provide an escape for the hotter inside air.

The details of the experiments and of the design will be discussed further.

#Second Award - Patent and Trademark Office/U.S. Department of Commerce/
Patent and Trademark Office Society

# COMBINATION OF LATEX, ACETIC AND FORMIC ACID IN RUBBER ELABORATION

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During the Pre-Colonial Era, the puertorican indians, obtained rubber out of different trees and plants. With this rubber they made their rubber balls. The purpose of this work is to demonstrate that combining formic and acetic acids in the manufacture of rubber out of Moracea and Allamanda violacea plants, it is possible to obtain more elacticity on rubber than those elaborated only with acetic acid Moracea and Allamanda violacea.

Different latex samples were collected from Moracea and Allamanda plants. Chemicaltests were made by mixing both formic and acetic acids to observe their reaction. Four different, formulas were used. Each formula was combined with the plants latex. The four different formulas were exposed to sunrays at different days. After that all four rubberbands weresubmitted to resistance and elacticity test using different volumes and their reactions were compared.

It was determined by the test, that by the use of formic and acetic acid in the manufacture of rubber, the product quality can be increased with the use of formula number two (a combination of 6 ml of acetic acid and 3 ml of formic acid) and the latex obtained from the Moracea and Allamanda violacea plants.

#Third Award - Institute of Electrical and Electronics Engineers

# INNOVATIVE HERBICIDE APPLICATOR

Ehlis, John A., St. Mary's H.S. New England, ND 58647;
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The modern-day farmer is a resourceful one. He will do whatever it takes to obtain the most bushels per acre. Plants that rob moisture must be controlled. This is done by applying herbicides which are expensive.

A standard liquid herbicide applicator consists of a spray tip that showers the chemical over the plants. However, when this is done, only the top portion of the plants may be wet. Little, if any, herbicide reaches the bottom portion. This is done to a canopy effect created by the plants.

Trying to answer this problem, an entirely new device is proposed that will bend over the plants being sprayed. It is placed directly ahead of the spray tip. The tip showers the chemical onto the now-exposed base of the plant as well as the top portion as it is released from the bending apparatus. Smaller, unwanted plants would also be more throughly wet.

Through experimentation, it was determined that the bending appartus gives better coverage to the crop being sprayed, resulting in better weed control and reduction in the amount of herbicides used per acre.

It was found that when the innorative application was used with Roundup herbicide, a 78% reduction would effectively control weeds. When Banvel herbicide was used, it was fould that the amount of the chemical could be reduced by 90% and still give effective weed control.

Since the appartus would be relatively cheap to build and less herbicide would be purchased, the farmer would save money.

#First Award - American Intellectual Property Law Association

# ROBOTICS WITH HUMAN FEEDBACK

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A great need exists in the robotics industry for more dexterous robots. Technological advances in control systems and mechanical designs are required. To demonstrate a solution to this need an interactive control system incorporating human feedback was integrated with a multi-degree-of-freedom robotic hand.

The procedure required designing and building: 1) a glove-type sensing unit to pick-up operator finger movement; 2) a three fingered, multi-jointed robotic hand; and 3) a servo-tendon system to transfer operator finger movements to the robotic fingers.

The operation of this system resulted in the finger movements of the operator being mimicked by the robotic hand both in position, and rate of movement. The commands were carried out immediately and continuously by the robot. Most profoundly, no operator experience was necessary to control the system successfully.

Continuing work underway by the author involves refinement of the robotic hand and development of an exoskeleton system to transfer arm and wrist movements.

Applications are widespread and range from improvements of existing robotic systems to a new generation of highly dexterous robots that could function with the intellect of the operator. Uses would include military, medical, toxic waste, space, manufacturing, nuclear facility decommissioning, and deep sea; basically in areas hazardous or uninhabitable to man.

#First Award - General Motors Corporation
First Award - National Aeronautics and Space Administration
Third Award - General Motors ISEF/Engineering
Honorable Mention - American Intellectual Property Law Association
Alternate to Scholarship - The Ohio State University

#GLASS CONCRETE: A NEW APPROACH TO WASTE MATERIAL USES.
I. MIX DESIGN. II. ECONOMIC ASPECT

Ortiz-Rodríguez, Marcos, José de Diego H.S. Mayaguez, PR 00708
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In order to prevent environmental pollution with non-biodegradable materials the use of crushed glass as substitute of sand in concrete mix was considered.

A mixture of concrete was prepared using crushed glass as fine aggregate in a design of a mix of 3,000 psi of compression. Six cylinders were used, following the standards set by the ASTM (American Society of Testing Material) for the compression test and several clubes of 8 cubic inches for the mortar cement test.

Two model houses were constructed. One was made using normal concrete and the other using crushed glass to compare energy conservation in both cases.

The economic aspect was evaluated, inquiries about availability of waste glass as raw material and technology related to crushing and handling of glass were made.

Data collected indicates that it is possible to substitute sand with crushed glass as fine aggregate in the manufacture of concrete since the results obtained are acceptable to the ASTM. The economic aspect showed the viability of production and handling of crush glass because the technology and raw material are available at relative low cost.

#Second Award - American Society of Civil Engineers
Third Award - Junior Engineering Technical Society

# FRACTALS AND CHAOS

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With the advent of efficient computers in recent years, chaos and fractals have been able to receive the deserved attention that bring many opportunities for research in this field.

The objective of this project is to study the interesting behavior of chaos and fractals of nonlinear dynamic systems through a microcomputer aided analysis.

Several interesting patterns of fractals were generated on microcomputers using an initiator, a generator and a simple nonlinear relationship. Results were obtained on a TV monitor and also on pen-plotters, producing patterns that were suprisingly similar to patterns in nature such as snowflakes and plants. This is due to repeated self-similarity inherent to the structure of fractals and to that of nature as well.

Regular and chaotic motions were obtained from a simple dynamic system called Duffing's equation by changing magnitudes of external forces and damping. It was found that regular and chaotic motion appears in an unpredictable manner.

Chaotic behavior and "strange attractors" shown by Lorenz were reproduced on the microcomputer. The chaotic behavior was shown in time-history plots and from a three dimensional view.

Such studies will make useful applications to many engineering and scientific problems.

#Scholarship - The Ohio State University
Summer Math Scholarship - The Ohio State University

# The Secondary Recovery of Oil In Abandoned Fields and Existing Flood Systems

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One of the most pressing objectives facing the United States today is an oil shortage and an embargo by foreign oil-producing countries, due to the growing dependency of the United States on foreign oil. I have formulated a plan that will help the United States decrease their dependency for this precious commodity. My proposal consists of three parts; Known technology, an oil recovery plan, and my respective conclusion.

The first volume of my project is an overview of the existing technology of the oil industry. The drilling and completion technology is well accepted among the experts of the oil industry all over the world. The objective of my plan is to maximize a recovery system for abandoned oil fields and existing flood systems. This plan will embrace some of the proven methods of oil drilling and extraction. My plan will show a better method of accomplishing more production from abandoned fields and existing flood systems at reasonable cost.

In the interest of the future security of the United States I feel that by focusing on the existing technology, including my plan, the American people would slowly reduce their dependency on foreign oil.

The time has come for the American people to face the reality that we should not be at the beckon call of the rich oil-producing nations. We have always been able to overcome adversity and energy shortages. The solution has always been available within us, and we must look again into our own natural resources to further advance existing technology for our self-preservation.

#First Award - Society of Exploration Geophysicists

AERODYNAMIC EFFECTS OF LATERAL COMPRESSION FIELDS ON THE RESULTANT WAKEFLOWS

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26137 Woodridge Dr., Elkhart, IN 46517

The purpose of this project was to discover if there is a relationship between the pressures in the wakeflow and bow wake of an automobile. It was discovered that a constant equal but opposite relationship does exist. Also, in the formal report, there is a discussion of the lateral compression of air as an automobile passes through it, along with a theory to the origin of the boundary layer. This study is a result of questions raised in previous projects. The results of these projects include: 1) A design of an underbody wing used to fill the afterbody cavitation of an automobile; and 2) A proposed front-end design for automobiles.

#PROSTHETIC APPARATUS

Fergusson, Scott Owen
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R.R. 8, Columbia City, IN 46725

An artificial hand and arm were built using synthetic (PVC, galvanized steel, aluminum) materials. The apparatus imitates a human hand and arm in both structure and function. It is constructed with phalanges, carpels and metacarpels. A working ulna and radius is also present. The hand and arm is controlled by a Commodore 64 microcomputer which communicates with a parallel 24 bit I/O card and a researcher designed prosthetic manipulator card, which commands the arm. The fingers bend in 3 axes. The thumb can bend and the wrist can rotate. Currently, control is precise to 1/50th of an inch. Sensors tell the computer when each finger is closed to its full extent.

The aim of further research is to integrate a vision system and to perfect the hand-arm to serve as a replacement.

#Second Award - General Motors ISEF/Engineering

MYOELECTRIC CONTROL WITH TACTILE RESPONSE

Cameron, Stephen M., Evergreen H.S., Metamora, OH 43540
305 West Morenci St., Lyons, OH 43533

A myoelectric (muscle electricity) control circuit was developed to be used to control a complex prosthetic device. Two devices were constructed to be controlled, one simple device, a knee joint, and one complex device, an arm-hand combination. A computer control was then built to test the devices. After the devices were tested, a myoelectric control circuit was then built. Several problems were encountered during the construction of the circuit. However many of the problems were resolved with further research. One problem that was not resolved was the problem with outside interference. The circuit picks up the one millivolt given off by the muscle and amplifies it, but along with the one millivolt, it also amplifies the interference. There are also problems with finding enough muscle groupings to control a complex device. With further research it was discovered that the myoelectric circuit may not be as practical as first expected. It was found that the use of a myoacoustical, muscle sound, control system is easier to use and has less problems with interference. This new type of control circuit may be an easier type of controller to train prosthetic patients with and may also have a wider range of applications than the myoelectric type controller. Further research into the specifics of the myoacoustical circuit are planned.

#Fourth Award - General Motors ISEF/Engineering

COMPUTER CONTROLLED MEASURING MACHINE

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983 Livingston Dr., Xenia, OH 45385

The goal of my project was to build a machine that would measure the heights of various objects to within a few thousandths of an inch.

A mechanism was construsted consisting of a stepper motor, a lead screw, a following nut, a guide rail, a sliding arm, an object sensing switch, and miscellaneous parts. The mechanism was connected to a Commodore 64 computer system via an integrated circuit.

Special software was written to control the mechanism, recording and processing measurements. The software was written in a combination of both BASIC and machine language. It is menu driven and includes functions for deciding if a measured object is within tolerance and for statistically processing measurements.

Tests were performed to determine the accuracy and repeatability of the system. Results of the tests show that the machine's measurements were accurate to within .0017 inch and it repeated to within .00051 inch. The conclusion is the machine exceeds the stated goal.

Such a machine could be used to measure the heights of manufactured parts. Knowing the size of a part is the first step in controlling its size.

#First Award - Society of Manufacturing Engineers
Second Award - General Motors ISEF/Engineering

# THE DESIGN, CONSTRUCTION, AND TESTING OF AN EXPERIMENTAL SEAWALL

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The beaches of the earth are wearing away. The primary cause of the erosion is the wave. The wave's constant movement deprives the coastline of necessary materials, such as sand. Seawalls, at present, are one of the key structures used in the defense of these coastal regions. However, these units are not totally efficient and may, at some point, harm instead of help.

A new seawall unit was designed which could possibly provide more adequate security for beaches. The name given to the unit by this researcher is the slope-valley seawall. It features a deep valley with two forward slopes, one overhead and the other on the ground. In this research, the structure was compared to an unprotected shore area and to a combination curved and step-face seawall. They were exposed to simulated sea conditions for a certain period of time. The conditions were produced by a wave machine that was built by the researcher. The objective was to limit the amount of change immediately in front of and behind the seawall. The experiments indicated that the experimental seawall had a greater efficiency margin than the other two test units. Since the design for a slope-valley seawall has proven to be successful, this unit can be installed on beaches that are presently unprotected, and as a result, the deterioration time table for these beaches will be decelerated.

#First Award - American Society of Civil Engineers
First Award - General Motors Corporation
First Award - Marine Technology Society/U.S. Naval Institute
Fourth Award - General Motors ISEF/Engineering

# COMPUTER CONTROLLED BLOWER

Lebouitz, Kyle Stanton
York Country Day School, York, PA 17403
303 Brookwood Drive, York, PA 17403

The computer controlled blower is a new look at conventional superchargers. This blower injects controlled air into an engine to increase its performance. Conventional blowers can cause damage to the engine and give poor fuel economy. A turbo is more efficient than a blower; however, there is even less air pressure control than ordinary blowers which give a turbo-charged engine poor acceleration.

I used a computer to read in the pressure created in the intake of the engine. A transducer is used to give the computer a number related to the pressure. After the computer interprets this number, it determines if a change in the blower's speed is necessary. If so, it sends through the computer's user port voltages which control the speed of the blower.

The blower is a squirrel cage fan. This is the most practical blower since it is available at a reasonable cost, but in later modifications I will experiment with a high speed impeller used in turbos. An impeller such as the one described will increase the engine's performance since it can inject more air at a higher pressure.

In conclusion, the computer program I made is fully programmable so the user can set it to achieve maximum performance. These numbers can be loaded and saved on disk for later use. This solves many of the problems of blowers and turbos.

#Fourth Award - General Motors ISEF/Engineering
Alternate - U.S. Department of Energy

# BEEP BEEP: AN AERODYNAMIC STUDY OF AUTOMOBILES

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The study of a fluid and its effects on an object is the subject of AERODYNAMICS, and it plays a new major role in the design of automobiles. The purpose of this three year study is to closely examine the results of pressures on model cars then study the contours to comprehend the engineered aeridynamic design chosen.

First I learned the basic principles of aerodynamics, such as Bernoulli's Law and Newton's Conservation Laws, and I studied the use of wind tunnels by aerospace and mechanical engineers in the field of fluid mechanics. Next I built twenty-one models one-twenty-fourth the actual size and two wind tunnels. The second wind tunnel had a fixed plane, a closed chamber design, directed in and out flow, a turbulence reducer, selected speeds of forty-five, fifty-five, and sixty-five mph winds, and a manometer which measured horizontal and vertical pressures. I used this tunnel to find the lift and drag coefficients at critical points around the autos.

By studying the cars' shapes through my data I understood the needed pressures for good road handling and better gas mileage. At the end of my study, I was able to design autos with sharp aerodynamics according to specified criteria. Aerodynamics are definitely changing the future of the automobile industry, but its influence is being felt in many other areas as well.

#First Award - General Motors Corporation

ENVIRONMENTAL SCIENCES

# Acute Selenium Toxicity in the Freshwater Ecosystem

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The acute toxicity of selenium in the freshwater ecosystem was tested. The effects were determined on four organisms (*Euglena gracillus*, the copepod *Cyclops*, the shrimp *Paleamonetes*, and the snail *Helisoma*). The organisms were exposed to varying concentrations so selenium (.01, .05, .1, .5, 1, 5,10, and 50 parts per million(ppm)). As expected the higher concentrations of selenium caused the highest mortalities. The effect of sublethal concentrations of selenium on the reproduction of shrimp and snails was also tested. The animals were exposed to .01ppm and .05ppm of selenium. At the end of the experiment, two months, there was no indication of selenium hampering the growth and development of snails. The possibility of Euglenoids being a biological indicator of selenium contamination was also investigated. Five species of euglenoids were exposed to the entire range of selenium concentrations. At the conclusion of the experiment there was an evident line of survivability. This line indicates that euglenoids may be used as an excellent biological indicator of selenium contamination.

#Third Award - Bureau of Reclamation/U.S. Department of the Interior
Fourth Award - General Motors ISEF/Environmental Sciences

#LEAD POLLUTANTS IN PLANTS GROWING ALONG ROADS

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The purpose of this investigation was to compare the amounts of lead in plants and soils in ditches along state highways and county roads with soils and plants from farm fields. Plant and soil samples were collected from ditches along roads and from farm fields at least 300 M. from roads. The samples were prepared and analyzed for lead content with an atomic absorption spectrophotometer.

Soils and plants from ditches along state highways contained very high levels of lead, averaging 65.4 PPM for soils, 32.4 PPM for broad-leafed plants and 5 PPM for narrow-leafed plants. The soils along county roads averaged 27.4 PPM while the broad-leafed plants averaged 6.4 and the narrow-leafed plants averaged 3.4 PPM. The soils from farm fields averaged 11 PPM, the broad-leafed plants 4.6 PPM and the narrow-leafed plants 4.6 PPM.

People shouldn't plant gardens near busy highways or make hay for animals from roadside ditches to prevent lead poisoning in themselves or their animals.

#Third Award - General Motors ISEF/Environmental Sciences

HOW TEMPERATURE AND CHEMICAL CHANGES IN THE ENVIRONMENT AFFECT THE SURVIVAL OF MILNESIUM TARDIGRADUM WHILE IN A CRYPTOBIOTIC STATE

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The purpose of this project was to discover how resistant the cryptobiotic forms of *Milnesium tardigradum* are to temperature and chemical changes that they are subjected to in their environment. Tardigrades exploit cryptobiosis after being almost completely dried out, and are able to survive in this condition for long periods of time.

For the first part of the experiment, ten active tardigrades were chosen for each study. These microscopic animals were allowed to dry at room temperature, and each group was then subjected to a different temperature for fifteen minutes, rehydrated, survivors counted and evaluated for weak and strong individuals, then allowed to dry. After 24 hours, the same groups were subjected to the same temperatures each had been in previously for a longer period of thirty minutes each. The procedure was repeated at lengths of 45 and 60 minutes. The tardigrades seemed to react best to warmer temperatures.

For the second part of the experiment, groups of 10 active tardigrades were chosen and allowed to dry. These were rehydrated with water which contained pesticides and counted and evaluated at 15 minute intervals until the 60 minute point. Diazinon was the only pesticide which did not seem to affect the animals.

The third part involved the reviving of tardigrades in high oxygen-content water and low oxygen-content water. Without the presence of oxygen in the water, many of the tardigrades went into a state of suspended animation known as anoxybiosis and did revive when rehydrated in water that contained oxygen.

PHOTOSYNTHESIS: THE BREATH OF LIFE FOR MAN IN OUTER SPACE

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The purpose of this work was to develop a means by which to measure and compare oxygen production in aquatic and terrestrial plants.

Ten grams of leaves from a terrestrial plant were blended with 250 ml of distilled water. The pH of each blended solution was determined. Potato water was combined with each solution to adjust the pH factor to 7.0. The solution was purged with nitrogen gas for a period of one minute. The solution was injected with 30 cc of CO_2. The flask containing the prepared solution was sealed with a dissolved oxygen probe. The probe was used to measure the amount of oxygen being produced during photosynthesis.

The flask containing the solution was stirred under two 300 watt light sources. Every fifteen minutes for the first two hours, temperature and oxygen readings were recorded. For the next ten hours, readings were made every thirty minutes. This process was repeated fifteen times.

The percentage of oxygen dissolved in the solution at the final reading, was less than the percentage at the first reading. Two reasons for this to have occurred might be: the probe is absorbing oxygen or the plant itself, consumes oxygen in its free form, faster than oxygen is being produced during the process of photosynthesis.

ELECTRO- CHEMICAL WATER CLARIFICATION

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The purpose of, "Electro- Chemical Water Clarification: A Solution to Industrial Water Pollution?", was to find a safe and effective way to combat water pollution in our environment today. To prove the hypothesis that Electro- Chemical Water Clarification is a safe and effective way to battle the problem of water pollution, and will with regards to pH, percent of particulate matter, and the Chemical Oxygen Demand (COD), support life in the effluent, I followed several different steps. First, I clarified 48 different environmental water samples from my parish. They were then tested for pH, percent of solutes, and CODs. The effluent was then tested on life: plants and brine shrimp.

In conclusion, I found that Electro-Chemical Water Clarification is a safe and effective way to solve some types of water pollution, but is dependent on the percent of particulate matter in the influent. The chemical composition, COD, and pH are major variables in the effects of the process on life and in some instances it's clarification.

#AN EVALUATION OF LEMNA MINOR AS A BIOLOGICAL FILTRATION AGENT

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This author's past research has shown the ability of Lemna minor to survive and reproduce in the presence of metal pollutants. The purpose of these studies was to evaluate Lemna minor's potential for serving as a biological filtration agent. The present phase of this experiment sought to determine if Lemna minor could absorb and store lead in its tissues. Two batches of L. minor were grown in 10ppm lead for seven days. Samples of the culture medium were taken at the start and the end of the experiment. The lead content of the plants and the solutions were analyzed in a graphite furnace. In the first run, the lead content of the solution decreased by 2.7 mg/L and the average amount in the plants rose to 1.7 mg/g. In the second run, the lead content of the solution decreased by 1.1 mg/l and the average amount of lead in the plants was 4.4 mg/g. It can be concluded that Lemna minor can thrive in lead - contaminated environments and at the same time absorb lead from the waters.

#Second Award - Water Pollution Control Federation

THE MEASUREMENT AND CONTROL OF NOISE IN THE COMMUNITY

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Noise within a community has become an issue of increasing concern for local government in the past 20 years due to recent studies that have shown the adverse effects of noise on the health of people. The researcher conducted several tests to measure the noise produced by various land uses in the community. These were compared to the acceptable noise standards outlined in the Lexington County Zoning Ordinance. The researcher also tested methods of noise control, such as the use of distance as a buffer area and the use of natural and man-made barriers. Several land uses that were measured exceeded the acceptable levels. Distance was found to be an effective way to decrease noise, as well as the use of man-made barriers. The placement of buildings on a site was shown to be another effective way to deal with noise. Vegetation was the least effective barrier.

#WHICH FILTER WILL BEST REDUCE THE EFFECTS OF AUTOMOTIVE EXHAUST ON CHICK EMBRYOS?

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In previous research I found charcoal to be the best filter of those selected for testing in reducing the effects of leaded and unleaded gasoline on early developing chick embryos. In expanding my experiment I selected furnace filters, insulation and cigarette filters for testing. I hypothesized that insulation would work best. Six fertile chicken eggs were used in each experiment with leaded and unleaded gasoline being checked on each filter. Eggs were placed in Ziploc bags and incubated for four days. The eggs were then opened and the effect determined by measuring the crown to nose length of each embryo. Furnace filters proved to be more effective in reducing the harmful effects of exhaust fumes of both leaded and unleaded gasoline than insulation and cigarette filters. They were even better than charcoal for the unleaded gasoline.

#First Award - American Veterinary Medical Association
Third Award - General Motors ISEF/Environmental Sciences

FORMATION OF MULTICELLULAR ORGANISM WITH CONCENTRATIONS OF TERATOGENS

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To see the effect of different concentrations of teratogens on the cellular slime mold, Distyosielium discoideum and on the offspring. Teratogens used were P60 (lead oxide) and HgO (mercury oxide). Concentrations of 1M, .1M, .01M, and .001M were used of each teratogen. The plates were observed every twelve hours.

The growth patterns of the slime mold differed with each concentration. The plates in the .001M concentrations sent off offspring but tne offspring did not mature. The plates in the 1M concentration had retarded growth and never sent off any offspring.

Each plate of slime mold was affected by any exposure to teratogens. Humans are the same way. Sometimes the body collects and stores the teratogens until there is a high concentration which causes damage.

Future ideals: to try and find a way to protect an organism from teratogens or a way to cure effects of teratogens, To ultimately cure birth defects.

# 2nd YEAR STUDY EARTH'S NATURAL FILTERING SYSTEM

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ABSTRACT

Do pesticides react differently in the various soil layers of the earth? Through my first year experiment, Earth's Natural Filtering System, I discovered certain pesticides will adhere to soil particles, disolve via microbial and by chemical reactions. I determined that the soils in Florida are capable of preventing some chemical intrusion into the underground water system. This year, I plan to determine which soil layer has the most effect on the pesticide, Diazinon, an organic phosphorus.

I expect to determine this by taking sterile water that has been polluted with the pesticide, Diazinon, and draining it slowly through six different cylinders containing soil samples to top soil, sand and clay mixture, clay and sand mixture, 80% clay, clay diminishing into sand, and limestone. I will then take the water and soil samples to the Pesticide Research Laboratory at the University of Florida. At the Pesticide Laboratory I will do soil and water extractions to prepare them for the Gas Chromatograph Analysis. I will also do a pH test on each soil sample. This will allow me to find out which soil layer has the greatest effect on the pesticide and to determine what may have happened to the pesticide in each type of soil.

#Third Award - Association for Women Geoscientists Foundation

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A FOUR YEAR STUDY INTO THE EFFECTS OF THE INDUSTRIAL IMPACT ON SELECTED AREAS AND ECOLOGICAL SYSTEMS

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The purpose of this project was to analyze air, water, and soil samples in St. James Parish for chemical contaminants. PHASE I--water testing for pH, mercury, lead, nitrate nitrogen, phosphorus, BOD, phosphates, fecal coliform, nitrates, cadmium, copper, arsenic, and zinc--showed stipulations met with E.P.A. standards. PHASE II, soil testing, found the average cation exchange capacity and percent base saturation were below normal and pH average. Potassium, nitrogen, and phosphorus amounts met with E.P.A. standards. PHASE III air testing, conducted with a gas chromatograph, showed total suspended particles, sulfur oxide, carbon monoxide, nitrogen dioxide, ozone, hydrocarbons, and lead met with E.P.A. standards. PHASE IV showed crawfish and fish both had susceptibilities to 11 parts acid per 1 million parts water. PHASE V indicated alpha and beta particles in water were below normal. Water was not analyzed for gamma rays. Soil samples showed alpha and beta particles slightly higher than E.P.A. stipulations. Gamma ray levels in soil were higher than E.P.A. standards. PHASE VI exposed Staphylococcus Albus, Alcaliginesas Albus, and Escherichia Coli to UV radiation for two-minute intervals for 15 minutes showing the average colony to be 10. After exposure, colony counts were reduced to 4 with mutations. PHASE VII, gypsum vs. aquatic life, showed isotopes P_{32} and I_{125} to cause decreases in the crawfish and shrimp embryo production. Hatchability time also increased by 24-30 hours in both species with mutation occurring in the second generation. In conclusion, St. James Parish is within the maximum range of chemical pollutants. Overall, industries in the parish have sufficient waste monitoring equipment for protecting the environment.

# PHYSIOLOGICAL ECOLOGY OF *PSEUDOPLEURONECTES AMERICANUS* IN RELATION TO PLANKTOBENTHIC VARIABILITY

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A new multidisciplinary early warning system approach was developed to provide information on the increasing degradation of coastal ecosystems. The system is based on a measure of the comparative physiological condition and community structure of local marine habitats. Specifically, examination of the differences in excised liver RNA/DNA ratios of Winter Flounder, *Pseudopleuronectes americanus*, collected from two coastal sites, a salt pond and an embayment, were related to measured differences in local benthic and planktonic ecosystem communities and environmental variables. The flounders' nucleic acids were used to evaluate efficiencies of short-term growth. Ecosystem variability was based on a 3 year time-series approach to measure several bioenvironmental variables. This strategy utilized home-made devices to sample salinity, oxygen, phosphate, chlorophyll, and plankton. In addition, artificial substrates were used to periodically measure changes in the benthic communities. The salt pond site was inhabited by an abundance of the preferred prey types of Winter Flounder which, in turn, enhanced the flounders' physiological condition in comparison to the embayment location. However, low phosphate values and high chlorophyll biomass in the pond provided a source of organic enrichment that is interpreted as an early warning sign of growing eutrophication and potential for anoxic benthic conditions. The system also proved effective in detecting a recovery of benthic mussel populations depleted during a picoplankton bloom in 1985 at the embayment site. This inexpensive monitoring system, if implemented on an international level, could provide sufficient information to ensure proper management and protection of nearshore ecosystems.

#First Award - U.S. Navy
Second Award - General Motors ISEF/Environmental Sciences

COMPARATIVE AND CUALITATIVE STUDY OF THE EFFECT CAUSED BY POLLUTANS ON MACROSCOPE BENTHIC ALGAE OF PUERTO RICO SOUTH COAST.

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The sea has always considered the place nature has provided for our waste.The effects of the pollution are felt and seen all around us. In order to establish the effect of pollution over marine algae, four algae were chosen (**Ulva**,Padina, Dyctyota and Caulerpa),these were polluted with petroleum,sewage and cement. The results obtained through visual observations determined changes in the structure and the pigment.These observations are not conclusive , therefore , the cromatography were used to establish the pollutants in the algae extract.

The pollution effect grow from day to day. The results of the controled study have various limitations, wherefore the algae selected were in their natural state and that had indication of being polluted. In Lajas, the first place I went to,the effects of pollution caused by the illegal house boats and those caused by the recreation center (La Parguera) were established after one and half month. In Ponce and Guanica four algae showing great effects of pollutans were selected, most of the pollutans were domestic and industrial .In Guanica drastic changes of hydrocarbons in four algae were industrially polluted.

The loss of photosynthesis or reduction in reproduction are parts of the results of pollution , caused by the degradation of the environment in which we live.

SOLAR PONDS PHASE III: THE EFFECTS OF DIFFERENT SALTS ON HEAT RETENTION

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A salt gradient solar pond is a shallow body of still water that collects solar radiation and stores it as heat that is then converted to electricity. This is done by placing a layer of salt water under a shallow layer of freshwater, so that when the pond is heated, the brine will resist rising to the surface as warm water ordinarily does. This prevents the formation of convection currents and allows the storage zone of the pond to become extremely hot. This project tests four different types of salts - NaCl, Na_2CO_3, $NaHCO_3$, and $MgCl_2$ - to determine which, if any, would promote the greatest heat retention. Such information could then be used to determine which salt will be most feasible for a given solar pond. Each salt was mixed into a solution determined by its solubility, and was heated and cooled in cycles representing day and night. Results show that NaCl retained the most heat, followed by Na_2CO_3 and $MgCl_2$, and $NaHCO_3$. These cooling trends can be largely attributed to the solubilities of the candidate salts. The concentration of the solution determines the density of the storage zone of the pond. A higher concentration of salt is desired so as to reduce convection currents to the greatest extent possible. In this experiment, solubilities of the different salts resulted in solutions by weight percent addition of 25% for NaCl, 25% for $MgCl_2$, 15% for Na_2CO_3, and 10% for $NaHCO_3$. Looking at this data, it is easy to see how NaCl was able to retain more heat. Due to its wide availability, this salt is used most often in ponds. As a lower concentration of Na_2CO_3 produced the same results as a higher concentration of $MgCl_2$, it can be concluded that it would be the second most desirable salt. The low solubility of $NaHCO_3$ makes it the least recommended salt for use in a solar pond.

#GROUNDWATER DISTRIBUTION OF RADON GAS

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Radon gas is an inert gas that is colorless, odorless, and tasteless. In recent years scientists have discovered that radon gas is bein trapped inside homes and office buildings in amounts above the safe level of four picocuries per liter. After the initial 3.82 days, radon has broken down into its half-life. Its cancer causing daughters, the most dangerous being polonium, are present. When a person is exposed to levels above the 4pCi/l for a long period of time he may develop cancer.

Radon is released by such natural resources as bedrock, granite, shale, and phosphate. At one time scientists believed that dangerous levels would occur according to their geographical location. This theory was proved wrong when in the sate of New Jersey, far from the Reading Prong or any other radon-releasing soil, the highest level of radon was recorded. The pCi/l count in the water was over two million. I wondered if the transportation and distribution of radon through water from known radon-releasing sites to non-radon releasing sites was possible, and if the radon transferred through the water could then be released into the soil and then into homes.

The east side of Citrus County is composed of phosphorous soil. The Florida Aquifer travels through this soild on its journey to the Gulf of Mexico. The information I have found could lead to be be beneficial in the explanation of where this dangerous gas may present a problem.

#First Award - National Water Well Association

#OLD YORK COUNTY LANDFILL: AN ANALYSIS OF PERIMETRIC GROUNDWATER

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Some of the most neglected problems are those involving municiple landfills. Groundwaters' suceptibility to contamination is probably the most important factor in a landfill's safe existence. The objectives of this research are to find the sequence of sediments down to the aquifer, and to determine the groundwater quality along the perimeter of the Old York County Landfill.

The procedure began with the sawing of slots on the piezometers. Next 5 borings were hand augered, and piezometers were installed, increasing the number of wells on the landfill's perimeter to nine. Soil samples were collected while augering selected borings. Wash gravel was poured around the piezometers and the wells were sealed. The temperature, salinity, and conductivity of the groundwater was determined by using a SCT Meter. Water table depths were also found for each well. Laboratory procedures included the weighing of specified amounts of water soluble salts of lead, zinc, manganese, cadmium, iron, and chromium. From these salts 200 ppm standard solutions were produced that were diluted to 100, 10, and 1ppm solutions. The standards were aspirated in an Atomic Spectrophotometer enabling the aspiration of the groundwater samples.

In conclusion, I can state that the quality of the groundwater along the perimeter of the Old York County Landfill decreases as it flows from the west end to the northeastern end. This drastic decrease in quality in such a short distance may constitute groundwater contamination.

#First Award - National Water Well Association
First Award - U.S. Army
First Award - Water Pollution Control Federation
Second Award - Federal Aviation Administration
Fourth Award - General Motors ISEF/Environmental Sciences

THE EFFECT OF CO_2 IN THE ATMOSPHERE ON THE GAIN AND RETENTION OF HEAT

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The purpose of this project was to determine if carbon dioxide has an effect on heat retention in the air and if it contributes to temperature rises in the atmosphere. The experimentation consisted of 11 tests using different molar quantities of CO_2 introduced into a plastic bag of constant volume (10 L) containing air. The fractional moles of CO_2 ranged from 0.01 moles to 0.10 moles. These varying concentrations of CO_2 were produced by reacting predetermineded stoichiometric masses of $CaCO_3$ with 150 mL of 2 M Hydrochloric Acid (excess). The resulting gas was introduced into the 10 L plastic bag through a delivery tube allowing the CO_2 to displace an equal volume of air. A thermometer was placed in the opening of the bag and the bag was sealed. The gas was placed under a 250 watt floodlight and the temperature was recorded each minute for ten minutes. The initial air-filled bag and the initial temperature of this bag served as controls to which the subsequent readings were compared. The results were tabulated from an average of three trials for each varying concentration of CO_2 in the bag.

The results of my experimentation showed that an increase in CO_2 levels in air increased the retention of heat and also caused the mixture to heat faster.

LEAF DECAY DYNAMICS IN A MANGROVE FOREST IN PUERTO RICO

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In mangrove forests, the large crops of leaves found on the forest floor suggest that their decay may result in correspondingly large amounts of essential nutrient elements being recycled from the trees back to the environment. The purpose of this study was to evaluate the importance of this process.

A mangrove forested wetland area in the Jobos Bay Estuarine Sanctuary in Puerto Rico was chosen. During the first phase of the study the diversity, density, and frequency of mangrove species were determined. The most dominant species were Rhizophora mangle (5740 ind/ha and basal area of 8.0 m^2/ha) and Laguncularia racemosa (1510 ind/ha and basal area of 4.8 m^2/ha). During the second phase, field experiments were conducted with leaves of the two dominant species. Several hundred mesh bags (mm^2 pore size and 10 x 20 cm area), loaded with 10g fresh leaves, were placed on the forest floor and six replicate bags per species retrieved at 0,2,4,8,16,32,64, and 256 elapsed days. Residual dry weght and element content were measured on the composited samples. The pattern of changeover time in the content of: 1) total dry mass, 2) nitrogen, 3) phosphorus, 4) potassium, 5) calcium, and 6) residual ash was analyzed graphically. The total dry mass of L. racemosa leaves, placed in the fringe decreased in 50% at the first four days. In contrast, R. mangle leaves in the fringe retain the 50% of the total dry mass during 128 days. In general, in both species (in the 256 days) Ca content did not vary appreciably. Total mass and ash dropped progressively. Virtual disappearance of K occurred. N and P content increased sharply over the initial 128 days. N remined above, but P decreased below initial levels by day 256. Rhizophora mangle leaves, simultaneously incubated in an adjacent mangrove canal, hypersaline lagoon as well as in fringe mangrove forest floor decayed at rates that decreased in the order canal>fringe>lagoon.

CONTAMINATION PREVENTION IN GOLD LEACHING

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Since time began man has lusted after a yellow mineral called gold. A method used to extract gold from a very low grade ore is 'Cyanide Leaching". The problem with cyanide leaching is if the cyanide should happen to seep into the water supply it would contaminate and prohibit the use of that supply.

My experiment will illustrate that the precautions taken by modern day miners will eliminate the threat of contamination. This project will indicate our concern for the environmental safety of future generations.

The pads used in leaching are constructed with layers of geotextiles, linear low density polyethelene liner, drain net, compacted clay and a tailing cushion. A leek detection system is also installed to provide a margin of safety. Leaching is the most effective and cost efficient method to obtain gold from mined rock. Leaching is a simple process of cyanide solution attaching itself to microscopic gold particles.

The result of "Contamination Prevention in Gold Leaching' is to protect our environmental resources for future use.

#METAL MINES IN PUERTO RICO, MYTH OR REALITY?: AN ANALYSIS OF EFFECTS OF METAL SALTS ON SEVERAL SPECIES OF CROP PLANTS

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Puerto Rico counts with a variety of mineral reservoir, among them we can find cooper, zinc, iron, and nickel. During the last years the explotation of this minerals has been a theme of great importance. This investigation attempts to study the possible effects of these metals in plants, essentialy in mancultured ones. Also the environmental impact that they will cause has been studied.

Concentrations of $CuSo_4$, $FeSo_4$, $Ni(NO_3)_2$, $ZnSO_4$ and HgO were used in the germination, development and growth of 5 crop plants. The study was conducted at three different periods as follows: 5 days, 10 days and 30 days. It was found that after a 5 day period $CuSO_4$ decreases greatly the length of the primary root and the number of secondary and terciary roots in *Cucumis sativus*, *Phaseolus vulgaris*, *Sorghum bicolor* and *Lycopersicum esculentum*. $CuSO_4$ revealed the most significant effects and $FeSO_4$ follows it in terms of harm caused. The production of dry matter also decreases greatly. The histological study revealed harm caused in different parts of the radical system. The worst harm was observed in *Cucumis sativus* treated with $Ni(NO_3)_2$ in where it caused severe deformation and necrosis of the cells.

The longest period of study (30 days) showed deformations of the cotyledons and of the apex, decrease of the size of *Phaseolus vulgaris* treated with $Ni(NO_3)_2$. Nickel toxicity symptoms include chlorosis and necrotic spots on younger leaves and internodes; premature leaf fall, and streak necrosis of the leaves, petioles and branches. At this time, tests with others metals are being carried out. The macro and micronutrients content as well as the pH of the soil and plant tissue are being determined.

In order to determine the amount of these metals present in the plants the atomic absorption spectrophotometry technique will be used.

#First Award - American Society of Agronomy
First Award - Eastman Kodak Company

# LIMNOLOGICAL STUDY OF THE LAKE OF LEVITTOWN. PHASES I - IV

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The contamination of the water in the rivers and lakes of Puerto Rico is a well known fact. The main goal of this research is to study the contamination conditions of an specific water body, and try to bring them to normal and allowed parameters. The first phase of this research was aimed to define and identify these conditions; bacteriological contamination was found. The parameters used in this phase were: fecal and total coliforms. The second phase of the research was focused on the chemical contamination of this man-made lake; large amounts of chemical waste were found in the lake. The parameters used in this investigation were: fecal and total coliforms for the bacteriological part and arsenic, barium, cadmium, chromium, lead, selenium and silver for the chemical part. The third phase of this research(1986-87) is aimed to present a projection of the contamination levels for the next five years in all of the parameters, and to study areal contamination in the same. The fourth phase of this research is a computarized study of one possible solution to the contamination of the lake's floor. The whole research is at the present time 3 1/2 years old.

#Third Award - American Water Works Association
Fourth Award - General Motors ISEF/Environmental Sciences

EFFECTS OF PESTICIDE DRIFT ON NON-TARGET ORGANISMS

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PURPOSE: To show that the effects of pesticide drift are very broad. Organisms affected may include plants, animals and humans.

HYPOTHESIS: Does pesticide drift, caused by the unwitting misuse of farmers, result in serious health and environmental hazards?

METHOD: The feed of nineteen pheasants was treated to simulate drift. Nine subjects served as a control group. The feed of five pheasants was treated with the chemical Orthene at a rate of 1/6 lb. per acre. The feed of the remaining five pheasants was treated with Glean at a rate of 1/3 oz. per acre. Behavior of the test subjects was monitored and eggs were collected. The Orthene test group showed behavioral change but the Glean group was unaffected. Shells of the eggs collected were tested for calcium carbonate content. The control group averaged 95%. The Orthene test group averaged 95%. The Glean test group had an average of 75-80%.

CONCLUSION: Due to the mode of action of the chemicals used only the Glean test group affected the calcium carbonate of the egg shells, however these tests do show that pesticide drift is damaging.

# AN ANALYSIS OF BIOLOGICAL RESPONSES TO IRRADIATION

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The research study involved analyzing how various plants and animals respond to irradiation. I utilized microwave, magnetic, x-ray, and ultraviolet radiation. First, I investigated the effects of microwave and magnetic radiation on zea mays. After gathering results on the germination, root length, and growth, and after performing a statistical analysis of the data, I concluded that the microwave radiation was detrimental in all areas, while the magnetic had little notable effect.

Next, I considered effects of x-ray radiation on chicken embryos. Results showed the ionizing rays to be a detriment in that it decreased weight, shortened appendages, increased deformities, caused cartilage formation in the heart and an excessive amount of glycogen to be stored in the liver. A statistical analysis proved this data significant.

I then began to research at the University of Nebr., Lincoln, under the direction of Dr. Eric Davies. In question was how pea seedling's production of proteins would respond to predetermined applications of ultraviolet radiation. In order to analyze this, it was necessary to isolate the polysomes from the tissue, separate them into different regions by gradient centrifugation, and monitor the absorbance with a density gradient fractionator. I found that though the lower levels of radiation enhanced polysome formation in order to increase protein synthesis, the higher dosages proved to be too great an obstacle for the plant's repair and defense mechanisms. Hopefully, this research will provide others with an awareness that although radiation is a natural part of our environment, there are many detriments to be acknowledged--perhaps even some that have yet to be realized.

#First Award - American Medical Association
First Award - General Motors ISEF/Environmental Sciences
First Award - U.S. Air Force
Scholarship - American Committee for the Weizmann Institute of Science
Operation Cherry Blossom Trip - U.S. Army

#REMOVING INDOOR POLLUTANTS

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When a house is energy efficient, indoor pollutants may build up. One of these pollutants is formaldehyde. Formaldehyde fumes come from materials such as carpets, draperies, urea-formaldehyde-bonded wood products, and foam insulation.

The purposes of this project are to determine (1)which house plant removes more formaldehyde from the air, the spider plant or the golden pothos, (2)how much formaldehyde is absorbed by potting soil, and (3) what effect the spider plant's plantlets have on removing formaldehyde.

To perform this experiment, it was necessary to pump formaldehyde fumes into an airtight chamber. The formaldehyde concentration was measured with Sensidyne Gastec Analyzer tubes with the aid of a Sensidyne Gastec hand pump. Six hours later a final measurement was taken. This test was conducted 3 times with each of the following placed in the chamber:

A. Airtight empty chamber
B. Potting soil
C.1 Spider plant and potting soil (plantlets exposed)
  2 Golden pothos and potting soil
D.1 Spider plant, plantlets exposed (soil covered)
  2 Golden pothos (soil covered)
E. Spider plant and potting soil (plantlets covered)

An analysis of the results showed that (1)the spider plant removed 15.2% more formaldehyde than the golden pothos, (2)on the average, potting soil absorbs 60.9% of the formaldehyde present in the chamber, (3) 38.0% of the formaldehyde removed by the spider plant was removed by its plantlets, and (4)the spider plant-soil combination removed 86.6% of the formaldehyde.

#First Award - Midwest Research Institute through its division, the
Solar Energy Research Institute
Honorable Mention - Federal Aviation Administration
Alternate - U.S. Department of Energy

A COMPARISON OF BLACKLAND PRAIRIE AND SURROUNDING COASTAL PLAIN SOILS

Lee, Yuti
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How does a Blackland Prairie Soil which does not support forest vegetation differ from the surrounding soil?

Blackland Prairie soil and the surrounding Coastal Plain soil in the forest area of Winn Parish's Kisatchie National Forest were collected. On site a hydrochloric acid test was conducted to determine if calcium carbonate was present. After drying the A and B horizons of the two types of soil for two weeks, lab procedures were performed to determine the chemical composition of the soil. Soil was tested for pH, phosphorous, and potassium . Soil texture was also determined. Afterwards, charts and graphs were drawn from the data.

High concentration of calcium carbonate was present in the A and B horizons of the Blackland Prairie soil, but none was found in the Coastal Plain's A and B horizons. Soils from the two sites differed in other ways also. For example, the A horizon of the Blackland Prairie had 0.1 ppm of phosphorous and the B horizon had 0.21 ppm; in contrast, the Coastal Plain's A and B horizons had less than 0.01 ppm of phosphorous. After the soil texture was determined for the two types of soil, the Blackland Prairie soil was classed into the clay section of a textural triangle while the Coastal Plain soil was classed into sandy loam. Based on clay content and X-ray diffraction analysis of clay from the Blackland Prairie, it appears to be a Vertisol soil.

#How the chemical and physical structure of soil is changed by increasing sodium levels

Bradford, Heather H., M-R Aca.,Madison, MS 39110
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My project deals with the physical and chemical changes which may occur with increasing sodium levels of soil. I ran the following to determine the characteristics of sodic soils: bulk density, moisture content, porosity, particle density, heat holding capacity, pH, pottasium, %OM, calcium, and phosphorus. A pH meter, flame photometer, and a spectrophotometer were used to run the chemical tests. The physical tests were performed on the dry core samples pulled directly from thr field. After the tests were run and the data was collected, I ran a statistical analysis test('T' tests) on some of the data to determine if the differences were due to chance or not.

After complete analysis, I concluded that high sodic soils do not affect any of the chemicals tested except organic matter. The results showed that after 400 pounds per acre, the %OM decreased steadily thus increasing the tendency for the soil to erode. Even though the rate of heat loss slowed in the higher levels, it was not large enough to cause any problems. Porosity of the higher levels was considerably less resulting in a greater bulk density(or compaction). The moisture amount of the 1455 ppa was almost twice as much as the control. The 876 ppa and the 1317 ppa showed in the 'T' results of moisture content that the changes may have been due to chance and therefore cannot be included in my conclusions. Further testing next year should result in a greater understanding of sodic soils.

#Second Award - Patent and Trademark Office/U.S. Department of Commerce/
Patent and Trademark Office Society

NATURAL INSECTICIDE: THE VOLATILE OILS IN CITRUS FRUITS

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The purpose of this study was to analyze the oils of citrus fruits as a possible insecticide. The chemical, limonene, is a well known compound that will kill insects as well as higher animal forms. The hypothesis of this work was to establish the possibility of developing an insecticide that will not pollute the environment. A method was developed to extract the volatile oils from three groups of citrus fruits: limes, oranges, and lemons. After extraction, infrared spectra-analysis and gas chromatography analysis were obtained to determine the composition of the oils.

In order to test for the toxicity of the oils on living species, a culture of Drosophila fruit flies was established in the laboratory. Tests were developed to determine the toxicity of the oils directly on the flies as well as on the life cycle of Drosophila melonogaster. Also, other insects were tested as well as other groups of organisms. Other compounds similar to limonene can be found in other plant organs such as caraway seeds. This compound, known as carvone, was extracted by ether extraction and analyzed by infrared spectrameter to see how it was related to the citrus fruit oils. Tests were also conducted with the carvone oil extract.

THE EFFECT OF ACID RAIN ON THE COTYLEDONOUS GROWTH OF THE ALFALFA SEED: STAGE II.

Mary Elizabeth Dueker, Belleville Township High School West, Belleville, IL 62223; 1200 State Street Road, Belleville, IL 62220

PURPOSE: The purpose of the two experiments was to determine the effects of acid rain on the cotyledonous growth of alfalfa seeds. To determine this, the seeds were exposed to the two main components of acid rain, sulfuric acid and nitric acid.

PROCEDURE: 1st experiment--In a series of test tubes, alfalfa seeds were first soaked and then allowed to germinate in various pH solutions of both acids. After a two-day growth period, the lengths of the cotyledons of each seed in each test tube were recorded for three one-day intervals.

2nd experiment--Using the same pH range as in experiment #1, the seeds were first soaked in both types of acids (constituting and acid shock), and then grown in distilled water. After a two-day growth period, the lengths of the cotyledons of each seed in each test tube were recorded for three one-day intervals.

CONCLUSION: Although not as pronounced as in prior experimentation, results acquired in stage II demonstrated the same tendency for lower pH's to retard seed growth.

The acid shock testings (exp. 2) seemed to have a more detrimental effect on seed growth than the continuous pH acid exposure, in that many of the growth patterns dropped after initial growth. Potentially, this could reveal an inability of the alfalfa seed to adapt to significant changes in pH environment after the early stages of the cotyledonous growth. The continuous pH testings did not show this significant drop in growth, indicating that the alfalfa seed can perhaps adapt to a constant pH factor.

My results reinforce the need for much more research of acid rain to better understand this complex ecological problem. If not stopped or controlled, the environmental impact of acid rain could be disastrous.

NEOCHETINA EICHHORNIAE CONTROL EICHHORNIA CRASSIPES

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There were four years of study in this project. The first three years were to see if Eichhornia crassipes were able to rid polluted water of phosphates, nitrates, and potassium This year Neochetina eichhorniae (a weevil) was used to control the water hyacinths (Eichhorniae crassipes).

The purpose of this project was (1) to prove that the Water Hyacinth could rid the water of a certain solution, the dye in the first year and the phospate in the second, (2) to prove that this could be done on a continual basis for a number of experiments, and (3) upon proving the Water Hyacinths useful for pollution reduction, trying to find an effective biological control for the Hyacinths. By using the Neochetina to control the Hyacinth, a natural bioligical method is used to control the Hyacinths.

Year I: Hyacinths were put into six seperate buckets and were used to remove a red dye from the water.

Year II: Hyacinths were proven to be a way to remove a water solution (a pollutant) from polluted wastewater.

Year III: The Hyacinths removed phosphate from water.

Year IV: Neochetina were placed on the leaves of the Hyacinths. They feed on the Hyacinths as adults by scraping their mandibles across the leaves and as larvae, by burying deep within the petioles. This causes massive damage to the Hyacinth. In this way the Neochetina can control the rapid growth of the Hyacinths. Controlling this expedient growth rate would allow the Hyacinth treatment system to be completed.

THE USE OF ARTIFICIAL SUBSTRATES FOR THE GROWTH OF ALGAE AND MARINE INVERTEBRATES IN FRONT OF THE RED MANGROVE, *RHIZOPHORA MANGLE* WITH EMPHASIS ON SUCCESSION ON AREAS WITH DIFFERENT DEGREES OF EUTROPHICATION

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This investigation consist in the localization of different artificial substrates in the marine environment in front of the red mangrove, *Rhizophora mangle*. The purpose is to determine if the deposition of organisms on the substrates takes place in a similar way to their depositors on this mangrove, a mangrove whose roots serve as an habitat for a large variety of marine organisms, common in the waters of La Parguera, Puerto Rico.

After the collection and investigation of the substrates formica and fiberglass, it was found that among the three stations used during the first year of study, big differentials of organisms exist. Barnacles were very abundant in the substrates and their main substrate distribution was along the borders of it.

During the second year of study the figerglass substrates was added and compared with the formica one, and the last one revealed a higher quantity of organisms.

The zone studied is invaded with floating houses that discharge fecal matter directly on the sea. This has caused a proliferation of algae growth. This is so because these continuous discharges contain nitrates and phosphates that produce an euthophed zone. As the proliferation of algae takes place, they displace the invertebrates that take longer to grow and which are also important components of the marine biota.

The results has led to postulate that the basis in the sector are attending the marine life and through the investigation, evidence in presented to substain one of the environmental problems that affects Puerto Rico today.

Tests for suspended particles are being made in both the substrate and the water around the substrates in order to try to determine is a comelation between the sediments and the deposition of marine organisms.

NITRATE CONTAMINATION IN RURAL AREA WELLS

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The purpose of this project is to determine if the rural wells surrounding my hometown of Viborg, South Dakota, contain nitrates. Groundwater nitrate contamination in wells can impose a potentially serious health hazard, especially to infants younger than six months. Nitrate nitrogen levels above 10 p.p.m. have caused methemoglobinemia, "Blue Baby Syndrome", which can be fatal.

Water samples were collected from eight rural area wells and tested with NitraVer 5 Nitrate Reagent containing cadmium. Nitrates will react with cadmium to form an amber color. The higher the concentration of nitrates the darker the amber color. Comparison of the amber colored test water to the test kit color wheel will then give the nitrate concentration in p.p.m.

I found the shallower the well the higher the possibility of nitrate contamination in the water. Also, the proximity of the well to the possible cause of contamination such as animal manure "feed yards", nitrogen fertilizers, or crop residue can increase nitrate levels.

If high nitrate levels are found in a well, one should locate the souce of contamination and remove it. If removal is not possible, some solutions for removal of high nitrate concentration include: ion exchange resins, electrodialysis, or reverse osmosis processes, all of which are usually cost prohibitive. More economical solutions include digging existing well deeper or locate another source of water.

I would recommend not using well water for infants if the water has any nitrate levels present.

#Third Award - National Water Well Association

#THE DYNAMICS OF CLADOCERA IN CHEMICALLY STRESSED ECOSYSTEMS.

Kar, Shonalie., Coon Rapids H.S., Coon Rapids, MN 55433
12074 Unity St., Coon Rapids, MN 55433

Freshwater phytoplankton and zooplankton are subjected to increasing chemical stress due to environmental pollution. This four year, four part study was done to (1) investigate lake pollution through acid rain and determine whether location was significant to the acidity of precipitation. (2)Determine the effect of simulated acid precipitation on two unrelated cladocera: Daphnia Pulex and Alona sp. (3) Research the addition of copper sulfate into lakes for algal control. (4) Study the dynamics of copper stressed cladocera: Daphnia Pulex and Daphnia Magna. The results of the acid rain pollution study (part 1) indicated that acidity levels near industrial sites were higher than levels in non-industrial areas but pH was low in non-industrial areas also. Results of the experiment (part 2) to study the effect of acid precipitation on two freshwater cladocera, supported the hypotheses that acid precipitation has an adverse effect on Daphnia Pulex and Alona sp.; and that Alona sp. could withstand greater acid stress than Daphnia Pulex. The study of copper sulfate and algae (part 3) was done to establish copper toxicity levels in lakes due to algal control and to determine indirect effects on freshwater zooplankton. The dynamics of cladocera under copper stress (part 4) was studied with a bioassay on Daphnia Magna and Daphnia Pulex. Results supported the hypothesis that copper sulfate would adversly affect survival, growth and reproduction of both species, even at recommended levels of application for algae control. Physical and behavioral changes were oserved in both species. The above studies together indicate a high level of chemical stress in the ecosystem. The need to implement measures to halt further deterioration of the environment is immenent.

#Alternate - U.S. Department of Energy

REMOVING ESCHERICHIA COLI WITH ANIONIC RESINS

Lum, William, Mather H.S., Chicago, Illinois 60645
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The purpose of this project was to locate the pH level(s) in which Dowex MSA-1 anion exchange resins were most effective in abstracting Escherichia coli from a commercial nutrient broth.

A stock nutrient broth was prepared. It was divided into seven equal segments. Six of the parts recieved alterations in the pH levels. Each acquired a different pH level. Each of the six broths were innoculated with equal amounts of E. coli. Five mL of each broth was introduced into and allowed to flow through its own individual pipette, each containing equal amounts of Dowex MSA-1 anion exchange resins. The effluents were collected and submitted into a spectrophotometer. The readings were recorded. The data were used to determine the percentage of E. coli removed at each pH level. Five similar experiments were performed.

The composite results indicate that at moderately low pH levels Dowex MSA-1 anion exchange resin's removal ability of E. coli increases as the pH increases. At an approximately neutral pH level the resin's ability reaches its maxium state. As the pH rises into the higher pH levels the resin's ability decreases until it falls into a pattern which displays minor deviations.

MECHANISM OF THE DEOXYGENATION OF AN ESTUARY

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Calle Gonzalo Gallegos, San Juan, PR 00926

Depth, salinity and dissolved oxygen (DO) were measured in the column of water of twenty-three sampling stations. Isolines for DO and salinity concentrations were drawn on a depth profile of the estuary. In order to obtain information about organic oxidizable pollution the biochemical oxygen demand (BOD) was determined in samples, both, of the column of water and the sediments in six different sampling stations. The Department of Natural Resources of the Government of P.R. helped us with equipment and laboratory analysis in this endeavour since 1983 to the present. The estuary was extensively studied in 1974 by different groups of investigators.

The low BOD and high DO consistently found in the fresh water layer of the estuary since 1983 demonstrate that water pollution by organic oxidizable substances has been significantly reduced in comparison to 1976. The BOD in the salt water layer is nowadays still lower than in the fresh layer but the DO continue to be as low as in 1976. We discovered that these low DO values in the absence of pollution in the salt water wedge are due to a powerful deoxygenation action originating in the sediments accumulated in the estuary (with no resuspension of the sediments involved). Our results suggests that a new wedge may be deoxygenated by this action to values below the standard of 5 mg/l in about a week. In agreement with this result, we found high BOD values in the estuarine sediments; in fact, sufficiently high to potentially drain all the DO available in the column of water several times.

Furthermore, we observed that this deoxygenating process cross the boundary between fresh and salt water intruding into the fresh water layer to the surface of the estuary. This vulnerability of the fresh water layer to the deoxygenating process reported here is what converts the Rio Grande de Manatí estuary in a poor receptor of pollution. This conclusion may be applicable to the other fifteen rivers that in the north and western coasts of P.R. are characterized by the presence of sand bars in their mouths and sea water penetrations.

#A COMPARISON: THE MUTAGENIC EFFECTS OF TOXINS ON PROKARYOTIC AND EUKARYOTIC CELLS

Matteson, Paul
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120 West Monroe, Colorado Springs, CO 80907

The purpose of this project was to see if six toxins that man puts into the aquatic environment have a mutagenic effect on prokaryotic or eukaryotic cells occurring in these water systems. The toxins tested were: xylene, copper, 2,4D, NaOH, H_2SO_4, and Sevin. The organisms were exposed to 3 dilutions of each toxin: EPA or recommended dosage, 10% above and 10% below that level. To determine if a mutagenic effect had occurred, I introduced antibiotics, streptomycin and tetracycline, to the prodaryotic cells (E. coli and P. aeruginosa). Nystatin was used on the eukaryotic cells (Rototorula). Antibiotics were applied to the cells before and after exposure to the toxins.

The prokaryotic cells (E. coli and P. aeruginosa) developed varying resistances to both antibiotics when grown in the presence of xylene, NaOH, H_2SO_4, and sevin. However, when the prokaryotic cells were grown in the presence of 2,4D and most of the concentrations of copper there was an increase in susceptibility to the tetracylcine and streptomycin. The eukaryotic cell (Rototorula) developed a complete resistance to nystatin after being grown in the presence of all six of the toxins. These mutagenic effects were retained in subsequent generations.

#Fourth Award - General Motors ISEF/Environmental Sciences

#THE EFFECTS OF TOXIC POLYNUCLEAR AROMATIC HYDROCARBONS (PNAs) FROM EAGLE HARBOR TIDAL SEDIMENTS ON PHYTOPLANKTON OXYGEN PRODUCTION

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In late 1985, the EPA declared Eagle Harbor a Superfund site due to polynuclear aromatic hydrocarbon (PNA) contamination from creosote. Within months the State Department of Ecology announced the need for an investigation to determine the effects of PNAs on phytoplankton. This study was designed to meet this need by determining the effects of toxic PNAs in Eagle Harbor tidal sediments on phytoplankton oxygen production.

Seven sites around Eagle Harbor with PNA concentrations ranging from <1 to 68 ppm were selected. In particular, sites near known creosote users were chosen due to their high PNA concentrations. Using the Light and Dark Bottle Technique, 50 g of sediment from each site was introduced to an indigenous Puget Sound phytoplankton population and its seawater sample. After 2-, 3-, and 4-hour exposures, the Classical Winkler Assay was used to differentiate oxygen concentrations in the samples as a function of PNA levels. A coefficient of variance was used to determine differences in oxygen concentrations. From the oxygen concentrations, gross primary production and chemical/biological oxygen demand were determined. As PNA levels in the sediments increased, dissolved oxygen concentrations of all water samples in both the light and dark bottles decreased while chemical oxygen demand increased. More importantly as PNA levels increased, phytoplankton oxygen production, i.e. gross primary production, decreased, indicating phytoplankton mortality. (All findings were significant at $p <= .05$.)

A highly significant consequence of polluting the phytoplankton is the shift away from the normal population balance, toward some unknown new community, with unpredictable results on the food web. Of even greater significance, 100% phytoplankton mortality in conjunction with staggering levels of COD and BOD can render a water body anoxic.

#Second Award - U.S. Air Force
Fourth Award - General Motors ISEF/Environmental Sciences

THE DETECTION AND ELIMINATION OF PETROLEUM BY-PRODUCTS FROM CHERNOZEM SOIL AND SIMULATED GROUND WATER

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1601 West Sixth St., Wamego, KS 66547-1125.

In this project, the purification of chernozem soil and simulated ground water was analysed. An experimental apparatus was constructed, and then filled with a given amount of chernozem soil. The soil was then contaminated with a petroleum by-product and daily purification with simulated ground water occurred. Core samples taken from the apparatus were then analysed by a gas chromatograph. The simulated ground water that exited the apparatus was tested with the use of a pH meter, pH paper, and Litmus paper. Data from the gas chromatograph was analysed with a compensating polar planimeter.

Evidence of purification was found. Compound quantities within the petroleum by-product were decreased in bottom level cores, mid level cores showed fluctuation during the experimentation, while the top level cores showed severe increases in compound quantities. Simulated ground water that exited the apparatus showed a definate evidence of petroleum by-product in primary samples and less evidence in the following samples. Thus, it is possible to conclude that purification of the chernozem soil and the simulated ground water may occur over a given time period.

#THE STUDY OF OPTIMUM PLANTING CONDITIONS OF SEAGRASSES WITH THE DEVELOPED SEAGRASS RECLAMATION SYSTEM

May, Elizabeth J., Titusville H.S., Titusville, FL 32780
101 May Drive, Titusville, FL 32780

Seagrasses provide the basic nutrient enrichment for marine life in estuarine systems throughout the continental shelves. Seagrass transplantation is gaining wide acceptance as a solution to the impairment of seagrass meadows lost to industrial pollution and coastal development.

In many cases, the methods used in seagrass reclamation today are very expensive and unsuccessful. The lack of success may be due to both ineffective planting methods and unfavorable environmental conditions in the planting area.

In the third phase of this project, a seagrass reclamation system was developed and tested, and was found to be highly successful. The fourth and final phase of this project dealt with the study of seagrass response to various environmental conditions including light intensity, light duration, temperature, PH, salinity, depth, and turbidity.

In each experiment, Halodule wrightii sprigs were transplanted into washed ocean sand in plastic pots and placed in filtered ocean water in 80 liter glass aquariums. Plants were clipped, measured and weighed before and after the test period. The environmental conditions of each aquarium were monitored for thirty days, with only one condition being allowed to vary in each test. The amount of variation was predetermined.

In order to successfully transplant Halodule wrightii, it was concluded that light intensity must be a minimum of 4000 lux, optimum light duration must be 15 hours daily, optimum salinity must be 20 ppt, optimum PH must be 7.0, optimum temperature must be 26 degrees C, and maximum depth varies as turbidity varies.

#First Award - General Motors ISEF/Environmental Sciences

#A NATURAL SWIMMING POOL

Scriver, John H., South Shore High School, South Shore, SD 57263
Box 43, South Shore, SD 57263

HYPOTHESIS: It is possible to economically purify an area of water for swimming in Punished Woman's Lake and other lakes with algae problems by using the lake bed as a filter.

PROCEDURE: To test my idea, a model proportioned to the lake's swimming area was made and tested. Core samples of the actual lake bed were used to build the model's lake bed. Algae water from an aquarium represented the water from the lake. The swim area was isolated from the rest of the lake model by a specially designed membrane. Water was pumped from the swim area into the water outside the membrane at rates from 10 ml per minute to 0.5 ml per minute that corresponded to replacement rates ranging from eight hours to over one week. The water was purified as it seeped back into the swim area by flowing through the lake bed beneath the membrane.

RESULTS: The water's transmittance of light was then checked at wavelengths of 660 nm, 530 nm, and 460 nm with a colorimeter. Before pumping, the average light transmittance of the water inside and outside the membrane was 52 percent. At the end of each trail period, the light transmittance of the swim area was over 98 percent, while the water outside the membrane was in its origional state.

CONCLUSION: This project proved the feasibility of a swim area restoration for Punished Woman's Lake and other lakes with similiar problems. I am contacting companies regarding sponsorship of a full-scale natural swimming area for Punished Woman's Lake this summer.

#Second Award - General Motors ISEF/Environmental Sciences

BIOLOGICAL EFFECTS AND DEGRADATION OF TOXICANTS

Diana Wuertz
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The biological effects and degradation of toxicants are important when considering pollution factors. The toxicity of the pesticide has an effect on both biological factors and degradation levels. A cycle test can be set up to test the pollution factors. The first part of the cycle is the introduction into the environment. Usage in agricultural regions are most common. The second part of the cycle consists of toxicity indicators used to check degradation levels of pesticides. The pesticide should determine the risk of contamination. The more toxic the toxicant the more persistent it is in the environment.

BOTTLED RADIATION

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571 E. 400 S., St. George, Ut. 84770

The purpose of this project was to determine whether: (1) fruit bottled downwind from the Nevada test site, during above ground testing, contained measurable radiation. (2) If there was radiation present, would it correlate with patterns developed from other studies. (3) It is possible to trace the patterns of fallout after several decades.

Fruit bottled during the testing period was tested by the Environmental Protection Agency in their laboratory in Las Vegas, Nevada. The results were analyzed and subjected to statistical studies in order to determine the kinds and amounts of radiation present, and to compare them with other studies.

Radiation was found in the 1962 samples. The types and amounts of radiation did correlate with a study done earlier on the Susquehana River in the New York area. It was concluded that patterns of fallout could be traced after several decades.

DEER FEEDING PATTERNS IN AN AREA

Clements, Tim, Tuscaloosa County H.S., Northport,Al
1165 Northwood Lake, Northport, Al 35476

The purpose of my project was to determine the feeding patterns of the Whitetail deer in Greene County, Alabama. I accomplished this by counting the deer in certain areas and keeping a journal of my findings. I also studied what the deer were feeding on in these areas. I found that the deer were feeding on oak acorns and rye grasses in the hardwood river bottoms. I concluded that as the temperature became colder, the Whitetail deer moved toward the hardwoods of the river bottom. At the beginning of my observations, the deer were scattered because of an abundance of food in most of the areas on club land. When the temperature dropped, the deer concentrated in certain areas. These observations were used to direct me toward areas that contained the most deer. By watching the deer in their feeding patterns, I was able to kill three deer this season.

#VIABLE COUNTING OF SOIL MICROBIOTA THAT UTLIIZE HYDROCARBON WASTES AS SUBSTRATES

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Soil is a unique medium that contains a diverse community of microorganisms. These organisms may be sparsely present or may number in the millions per gram of soil. They are responsible for decay of organic materials which may be spilled, dumped, applied purposely, or occur naturally. Consequently, qualitative and quantitative determinations of their presence and activities are desirable to predict the capability of undesirable organic materials which may reach the soil.

This paper reports the results from a study directed toward testing the hypothesis that natural soil contains microbiota that possess the capability to utilize a wide variety of hydrocarbon wastes as substrates. Agar plates conaining one of five hydrocarbon containing wastes (unleaded gasoline, creosote, crude oil, used motor oil, and oil contaminated soil) or one of three hydrocarbon compounds (hexane, toluene, and napthalene) were inoculated with serial dilutions from a solution made by adding one gram of soil to nine milliters of a sterilized solution. Naturally occurring colony forming units capable of growing on each type of hydrocarbon containing agar were enumerated after one week of incubation. This particular garden soil contained approximately 200 billion naturally occuring microbial colony forming units per gram dry weight. Approximately 20% of these were found to be capable of utilizing the crude oil, used motor oil, and oil contaminated soil as a substrate; approxiamtely 40% were found to be capable of utilizing gasoline as a substrate; however, less than 1 % were found to be capable of utilizing creosote as a substrate. Approximately 1% were capable of utilizing hexane while less than 1/2 of 1% were capable of utilizing toluene or napthalene.

#Fourth Award - General Motors ISEF/Environmental Sciences
Alternate - U.S. Department of Energy

IS THERE SYNERGISM BETWEEN MALATHION AND DIAZINON?

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Pesticides enter the Saginaw, Michigan environment in the summertime every year. Undoubtedly, they come in contact with each other. I wanted to determine if there is a synergism between Diazinon and Malathion when they come into contact with each other. In other words, I was determining if one enhances the capability of the other, possibly making them dangerous.

The LC50s of Malathion and Diazinon were determined first. Then, half of each LC50 was taken and put in 200ml of water with ten (10) Daphnia magna. The hypothesis was that this would kill 50% of the Daphnia. Other concentrations of the Malathion and Diazinon combined were also tested on the Daphnia.

Once the tests were done, the results were put together. For the concentration of half of the LC50 of Malathion and half of the LC50 of Diazinon, 45% of the Daphnia were killed. The expected percent dead was 50%. From this, I concluded that there is no synergism between Malathion and Diazinon. This is very important, because it is good to know that when these two pesticides come in contact with each other, they do not make each other more powerful.

#MICROENCAPSULATION PHASE III: TIME RELEASE NEUTRALIZATION OF ACID WATER BODIES BY MEANS OF ENCAPSULATION OF AN ALKALINE SUBSTANCE

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PURPOSE: To apply the past two year's research for a practical application and a possible solution to the acid rain problem.

PROCEDURE: Preparation of alkaline encapsulated microcapsules is approached by first emulsifying ethyl cellulose in cyclohexane. While agitating, sodium bicarbonate was added and the temperature raised. Next the solution was cooled first with a water bath, then with an ice bath. The result is a slurry, dull white solution filled with microcapsules. The capsules were then filtered and washed with water to wash any excess sodium bicarbonate which may be on the outside. The capsules were tested by placing equal amounts (by mass) into beakers containing a specific amount of water. Controlled amounts of hydrochloric acid were placed in the beakers. PH readings were taken periodically as the alkaline was released to neutralize the acid.

RESULTS: The capsules would dissolve only with an acid substance present. Once the acid was neutralized, the release of the alkaline substance halted until the pH was lowered again. This continues until all capsules are consumed.

CONCLUSION: There is a potential solution to the acid rain problem if the acid can be neutralized before the pH lowers to harm the aquatic life. These capsules insure neutralization without overshooting into an alkaline pH and shocking aquatic life.

APPLICATIONS: If these alkaline-contained microcapsules could be put in lakes that are susceptible to acid rain, in large enough quantities, many forms of life could be saved due to the fact that as acid precipitation falls, the alkaline would be released to neutralize the acid before lowering the pH to dangerous levels.

#Third Award - General Motors ISEF/Environmental Sciences
Alternate - U.S. Department of Energy

#EFFECTS OF THE HERBICIDE PARAQUAT ON EMBRYONIC DEVELOPMENT IN FISH

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Paraquat is a highly effective herbicide used mainly for weed control in commercial agriculture. Paraquat is preferred to herbicides such as 2,4-D due to its failure to bioaccumulate. In terrestrial environments paraquat undergoes photochemical degradation while adsorbed to plants and binds with soil components to become biologically inactive. Paraquat is also an approved aquatic herbicide. However, in aqueous environments paraquat does not undergo the same modes of degradation and could be a hazard to the aquatic ecosystem. The fish species Oryzias latipes, commonly known as the Japanese Medaka, served as the representative of aquatic organisms. The Medaka's unique breeding habits allowed the observation of embryonic development. The first series of experiments were designed to determine the teratogenic effects of paraquat through the observations of embryonic response. Over 300 controls were studied and more than 200 embryos were exposed to three established safety levels to distinguish normal and abnormal development. Establishing that paraquat was primarily a cardiovascular toxin under laboratory conditions, a series of experiments were conducted that reproduced more accurately the environmental interaction of paraquat. In the second stage of the experiment, 48 hour exposures at 2 ppm were initiated during the first 10 days of development to determine more precisely the susceptible stages of an embryo's development. Paraquat appears to be mainly absorbed by the epithelial tissues lining the cardiovascular system of the developing fish. Paraquat's action on animals is not entirely understood. A total of 1074 fish embryos were studied during the two years of research.

#Third Award - General Motors ISEF/Environmental Sciences

#CO_2 EVOLUTION AS A MEASURE OF OIL DEGRADATION IN SOIL

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CO_2 evolution is one way to determine the degradation rate of an organic substance in the soil, since microbial activity which causes the decay liberates measurable quantities of the gas. This experiment was designed to examine the amount of CO_2 produced when different amounts of motor oil were applied to samples of soil and to determine if adding a nitrogen fertilizer (urea) would increase the amount of CO_2 detected, and consequently the degradation rate of the oil. The effect of the urea placement was also studied.

In the original experiment, thirty quart jars were each set up with 300.00 grams of field soil. They were treated with varying amounts of oil and urea. The urea was placed on or below the soil surface. A CO_2 collector (10 ml test tube filled with 0.02M NaOH) was placed in each jar, and the jars were sealed. After time periods of 2.5, 7.5, 15, 22, 29, 36, and 43 days, the NaOH solution in each jar was titrated with 0.01M HCl. The test tubes were refilled with NaOH and returned to the jars. By processing the titration data through researched equations, levels of CO_2 were found.

The experiment revealed that the greatest oil degradation occurred in the first 2.5 days. An increase in the amount of oil alone did not always raise the amount of CO_2 detected. Urea caused the CO_2 level to rise, but only when oil was also present. A low rate of urea below the soil surface was more effective than a high rate placed on the surface. Additional results were obtained from a later expansion of the project.

#Fourth Award - General Motors ISEF/Environmental Sciences

ASSAYING THE IMPACT OF SUBLETHAL CONCENTRATION OF 2,4-D ON TWO HYDRA SPECIES

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Herbicides threaten the environment; 2,4-D poses a special problem to aquatic ecosystems. To scope this dilemma, an assay was performed to reveal the impact the sublethal concentrations of 2,4-D on hydra. Preliminary tests determined a range of concentrations that would manifest sublethal histopathologies. Hydra littoralis and Chlorohydra virdissima, with algal symbionts, being organisms indigenous to ponds and low on the food chain, were exposed. Regeneration was used to evaluate the magnitude of sublethal toxicity relative to concentration, species and exposure length. The impact on regeneration was assayed pictorially and qualitatively. Quantification required divising a unique scale based on a system of coefficients corresponding to developmental tentacle characteristics and degeneration. A Mean Regenerative Index summed the regenerative ability of each test group. Graphs revealed the dynamics of the regeneration patterns for each test culture and the interaction between the concentration levels for each day of exposure. MRI Values generated graphs for a regression analysis, calibrating a linear function which revealed regression as the slope. An ANOVA statistical 3-way analysis of variance revealed a significance level of .001 on all three levels of interaction among the concentration levels, exposure lengths and species. In conclusion, the data reveals 2,4-D has the potential to impart a powerful impact on an aquatic ecosystem relative to its impact on two hydra species.

#Second Award - General Motors ISEF/Environmental Sciences

#PRISTINES AND GOURMANDS: MANAGEMENT OF AN UNDERWATER ECOSYSTEM

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When man depends on a natural ecosystem as a major resource, he should manage the ecosystem to ensure its healthy existence. My project demonstrates population changes in a two-specie ecosystem in the presence of man to determine an optimum level of system management. Specie population is governed by predator consumption of prey, reproduction rates, man's harvesting efforts, and maximum population levels that the ecosystem can sustain. Using calculus, I studied how these variables affect specie population. I created a computer program that graphically displays specie population changes and extended the program into a computer game where the player manages the ecosystem through harvesting efforts, allowing the player to visualize the impact of harvesting versus economic gain.

My project simulates an imaginary underwater ecosystem. The lower level specie is named "Pristine", the higher level "Gourmand", and the harvester "Sea Hunter". The Sea Hunter fishes Pristines and Gourmands for a living, but if he/she overfishes and causes specie decline or extinction, he/she is out of business.

I determined mathematically the maximum rate of Pristine and Gourmand reproduction, maximum Pristine and Gourmand catch, and maximum economic returns for the Hunter. For constant specie economic values, it is most beneficial to fish at or under the maximum catch, keeping healthy Pristine and Gourmand population levels while reducing harvesting costs.

The computer program can easily be expanded to incorporate additional species and to include the economics of supply and demand. It is a useful tool in developing different management strategies for real life ecosystems.

#Third Award - General Motors ISEF/Environmental Sciences

A STUDY OF THE EFFECTS OF WET ACID DEPOSITION ON THREE SOIL TEXTURES

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Understanding and/or determining the actual effects acid rain has on our environment is an international concern. Interest in the damage believed to be caused by acid rain has been reported in the United States, China, Germany, Canada, France, England and many other countries. There is a need for additional research concerning the several areas of acid rain damage.

The objective of this project was to determine what effects, if any, acid rain had on three soil textures. Column leaching techniques and simulated acid rain were used over a prolonged period of time to generate data that would indicate the soils response to acid rain. This experiment was accomplished by leaching columns of each soil with the simulated acid rain with a pH of 3.6 or distilled water. The distilled water has a pH of 5.5 which is considered the average pH of normal rainfall.

The leachage was collected and tested to determine the amount of nutrients leached out of the soil. The soils were tested before and after the experiment to determine the amount of nutrients available to plants.

This study showed little difference in the amount of nutrients leached out of the experimental group as compared to the control group. Under certain conditions plant growth could even be enhanced by the addition of the nutrients found in acid rain.

#BIOACCUMULATION OF POLYCHLORINATED BIPHENYLS (PCBs) IN EARTHWORMS

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Polychlorinated biphenyls (PCBs) are industrial chemicals which have made their way into our environment. These persistent chemicals have contaminated the soil in a variety of means, one of which was contaminated farm silos. Previously, I measured concentrations of PCBs from .015 to 519 ppm in soils in and around farm silos that had been treated with a coating containing PCBs. Although soil particles bind PCBs, earthworms could bioaccumulate residues thus allowing them to enter the food chain. To determine if the earthworms would bioaccumulate PCBs, they were put into soil containing 0, 25, 50, 100, or 500 ppm of Aroclor 1254. Earthworms were dosed for 10 days with a 10 day withdrawal in clean soil. Throughout the experiment, pairs of earthworms were removed at 2 day intervals to determine PCBs uptake and clearance. Additional earthworms were dosed for 20 days. The earthworms bioaccumulated PCBs to steady-state by day 10 in all groups except the 500 ppm. The day 10 body concentrations were 3.061, 5.268, 14.507, and 65.132 ppm for the 25, 50, 100, and 500 ppm soil groups, respectively. The earthworms did not bioconcentrate the PCBs, and the concentrations of PCBs in earthworms declined 85% in 10 days of withdrawal. By day 20, the earthworms in the 500 ppm soil had reached 114 ppm PCBs and were displaying toxic signs. Since toxicity would limit high concentrations, it was determined that the PCBs contaminated earthworms would only harm species very susceptible to PCBs if they made their entire diet of the earthworms. Thus, there is little likelihood the amounts of PCBs picked up by the earthworms pose a hazard to wildlife or the human food chain.

#Third Award - General Motors ISEF/Environmental Sciences

#UV-B RADIATION'S EFFECT ON THE MARINE DIATOM, THALASSIOSIRA

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Studies at Oregon State University have suggested that the increased exposure to UV-B radiation that may occur as a result of the depletion of the ozone layer could force primary producers, such as the marine diatom, Thalassiosira, to migrate to avoid its lethal rays. It was the objective of this experiment to quantify this downward shift and to determine what effect it would have on the primary productivity of aquatic ecosystems.

Exposure chambers were made of glass tubing two centimeters in diameter and 45 centimeters in depth. Visible radiation was provided by two cool fluorescent Gro-Lux lamps and a Westinghouse FS20 fluorescent sunlamp provided the enhanced UV-B radiation. The difference in exposure between the two sets (UV-B transparent and UV-B filtered) was provided by two plastic filters; Kodacel (a 290 nm cutoff filter) and a clear Lee filter (a 312 nm cutoff filter).

Analysis of cell concentration at the beginning and end of each of two experimental runs at the depths of fourteen and forty-five centimeters showed that a surface irradiance of 1.4 watts/square meter in the 290-315 nm waveband resulted in significant downward migration of diatoms. Primary productivity studies (using the radiocarbon assay method) also showed that those diatoms that migrated as a result of the enhanced UV-B radiation were statistically less productive than those that did not migrate.

#First Award - General Motors ISEF/Environmental Sciences
Second Award - Marine Technology Society/U.S. Naval Institute

AN A"MAZE"ING FEAT: REGENERATED PLANARIA--SPRING WATER VS. ACID RAIN

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This project is the first step in a long experimental venture that is directed to determine the effect of simulated acid rain versus spring water on the brain of planaria, free-living flatworms. To accomplish this, the worms were trained to be as proficient as their brain mentality would allow in a Train-A-Tray maze which was made especially for planaria.

The first step in attempting to identify a problem occurring from a pH5 sulfuric acid rain was to regenerate black and white types of planaria in the opposing mediums. The experiment showed that second regeneration planaria placed in the solution of acid rain pollutants were slightly deformed. The question was to determine if the result was tissue deformity and/or brain damage.

The next step was to experiment and determine if regenerated worms in their native spring water would learn how to run a maze in less training time than those regenerated in acid solution. Each type of planaria was trained to run the maze by using a light followed by an electric shock to stimulate the planaria to make a turn that would be against its natural instincts.

In conclusion, the experiment discovered that the pH5 acid rain second regeneration planaria were not only physically deformed, but also mentally disabled. The difference in brain mentality between the worms in the opposing solutions occurred because acid rain pollutants damaged the nerves of planaria, which disfunctioned parts of the brain.

DIRECT AND RESIDUAL EFFECTS OF HERBICIDES ON SOIL BACTERIA A 3-YEAR STUDY

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Are the many various chemicals in use in our agricultural society having a detrimental effect on the normal soil bacteria? This is a question that I have been studying for the past three years and which I plan to continue to study in the future.

In this third year of study, a Direct Dilution Method was employed. Plots of ground were marked off in the summer of 1986, and herbicide was applied to these plots. Soil samples were collected directly and one week after application of the herbicide. These samples were then tested, by the Direct Dilution Method, for possible harmful effects on the soil bacteria.

Bacteria are absolutely essential to all soil processes. Soil bacteria carry out such processes as nitrogen, fixation and decomposition of humous material. I feel that extensive chemical use is damaging these bacteria, therefore lessening soil fertility. If this overuse continues, we may decrease the fertility of the soil to a point that could cause permanent damage.

We need to reevaluate our present agricultural methods concerning chemical use. It is also very important that we study this problem further so as to perserve this great natural resource for the future.

Future study on this topic will involve extensive work with isolated bacteria types. Also, long term herbicide effects will be studied as much as possible.

A METHOD FOR DETERMINING THE EFFECT OF REAL ESTATE DEVELOPMENT ON A BARRIER ISLAND

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The purpose of this study was to devise an easy method to determine effects of real estate development on a barrier island. It's assumed that a quick and easy method can be devised by comparing the geological and bioligical characteristics of an island undergoing development vs. one with no development. The basic method chosen to evaluate Mustang Island, a barrier along the Texas coast near Corpus Christi, was as follows: chart beach width and dune height, run plant transects, use photography to show damage, test soil for % composition and % humus, count and identify birds on beach, observe and record dune damage, and compare results to a protected barrier island. This method requires 3 to 4 days in the field and about two weeks for analysis. This could provide a useful and cheap method to monitor effects of island development as compared to nearby Padre Island National Seashore, which is prohibited from development. Results of geologic data showed a significant jetty effect. Soil analysis showed how new housing developments disturbed and change the natural makeup of the soil. Counting man-made trails on dunes indicated moderate damage on most of the island and heavy in the populated areas. This pattern was also seen in the dune height estimations, which showed significant damage to dunes where large numbers of people are. Biological data showed that the island's birds are mostly those well adapted to living in and near humans, but endangered species do exist and therefore should be protected along with their habitat. Plant communities are changing from a grassland ecosystem to a Chapparal type with more brush. The final conclusion is that this method does provide an accurate and easy way to identify environ mental changes that occur on a barrier island.

COMPARATIVE STUDY OF CRASH BOAT PILES ON NORTHERN COAST OF PUERTO RICO WITH EMPHASIS ON THE VERTICAL ZONATION OF MARINE INVERTEBRATES

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Crash Boat Piles has a great diversity of marine invertebrates being this area of great scientific, turistic and recreational interest and importance.

The purpose of my investigation is an attempt to established the vertical distribution of zones where marines invertebrates are living on the piles and determined how the environmental factors of surf, luminiscence and depht are limiting factors affecting negatively the vertical zonation of the organisms.

A variety of 58 marine invertebrates were located, identified and classified emphasizing its external and internal structure, distribution, position and number of species in each pile studied.

Using the quadrant technique species were found growing in small and big groups establishing a definite pattern of-growth and distribution from 30 meters up to the surface. Climatic factors such as environment temperature, wing velocity, atmospheric preassure, relative humidity were studied by using climatological instruments.

Results from the first phase of my investigation reveals four zones of ecological interest according to the dominant specie; *Balanus* zone, Tubastrea coccines zone, *Petaloconchus nigricans* zone and *Ailochroia crassa* zone (sponges).

At present study of the ecological niche is under way and a total of 58 species of fishes depend on the marine organisms living on the piles to feed. Also the factors of surf, luminiscence and depth causes great limitation to the development of the whole ecosystem.

KENTUCKY 31 EXCELS IN EROSION CONTROL

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Water erosion, often caused by the lack of proper vegetation, is no longer just a farm problem but is found today in urban and recreational areas, as well. The purpose of this project, therefore, is to discover what grass would most effectively reduce soil loss due to rain impact and water runoff on a sloped area. Once it is fully established, Kentucky 31(fescue) should have the best soil erosion preventing properties because of its excellent root system and its ability to tolerate poor drainage.

Five different grasses were tested: Derby rye (perennial), annual rye, Kentucky 31 (fescue), Rebel fescue, and Kentucky bluegrass. Topsoil without seed was used as the control.

A measured amount of soil and seed were added to five separate trays. The grasses were watered, fertilized and cut on a regular basis for approximately six weeks. A longer growth period would have been desirable and produced more accurate results. A heavy rainfall was simulated and water runoff collected from each sample and tested for its turbidity (amount of suspended particles).

Kentucky 31 provides the best protection because of its wide leaf, deep roots, and its ability to thrive in poor situations. The fast growing ryes did an adequate job, too, but have certain inherent deficiencies that limit their overall effectiveness. Slow growing bluegrass provides the next best protection after Kentucky 31, because of its superior sod and would be an excellent grass for erosion control if time is not a major factor in protecting the soil. Unfortunately, Rebel came in last in the testing because it did not have a thick sod nor adequate coverage.

AEROBIC AND ANAEROBIC DEGRADATION OF PENTACHLOROPHENOL

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Pentachlorophenol (PCP) is used in many agricultural and industrial applications as a herbicide, fungicide, and an insecticide. PCP is absorbed via dermal, oral and inhalation exposure in animals and humans, and can lead to elevated body temperature, hyperglycemia and cardiovascular distress. Because of large worldwide production and use of PCP, the intentional distribution of PCP-containing wastes is an increasingly important issue. In my research, anaerobically digested sewage sludge was added to soil to determine whether this sludge would actively enhance the biodegradation of PCP in soil. Degradation by chemical means pollutes the environment. Therefore, I wanted to observe the degradation under biological process that would leave no polluting residue. As a result of this research, anaerobically digested sludge was shown to enhance the biodegradation of PCP. At lower concentration, the indigenous organisms were active to degrade PCP under aerobic conditions, whereas they were inhibited at higher concentration. Mono-, tri-, and tetrachlorophenols were detected as degradation products. I propose the following degradation pathway for PCP: pentachlorophenol → 2,3,4,5-tetrachlorophenol → 3,4,5-trichlorophenol → 3-monochlorophenol. These lower chlorinated phenols are less toxic and are susceptible to further degradation aerobically or anaerobically.

#Third Award - General Motors ISEF/Environmental Sciences
Third Award - Water Pollution Control Federation

#IS THERE AN EFFECTIVE AND ECONOMICAL WAY TO SPEED UP THE PROCESS OF BACTERIAL DECOMP. OF WASTE MAT. IN ORDER TO MAKE SEWAGE TRT. MORE EFFECTIVE

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This project will determine which method of wastewater treatment bacterial decomposition of wastes is most effective, and design a new method of wastewater treatment that is practical and economical.

The procedure was done in three parts. In Part I, four principle treat-methods were tested-- aeration, stirring, temperature, and oxygen injection. This set of results showed that temperature and aeration were the most effective using BOD as a comparison.

Part II, the temperature and aeration tests were repeated. From these results, it was determined that it was more practical for a wastewater treatment plant to run its wastewater over a step process rather than to heat the sewage.

In Part III, the design of the step process was put to actual use by comparing it to a sample not treated by this new method. Trials were run by testing the step process for one hour, while, at the same time, letting a portion of the same original sample sit untreated for the same hour. The results conclusively showed that treatment by the new method was more effective than no treatment.

Next, an improved method of treatment by the steps was devised. This new method requires minimal space and helps control the quality of air around the plant.

Twenty-five percent of all U.S. wastewater treatment plants are simply lagoons. The 1987 "Clean Water Bill" will provide funds for cities to add this new process to their existing lagoon systems or any other type of treatment; therefore increasing water quality.

#First Award - Patent and Trademark Office/U.S. Department of Commerce/
Patent and Trademark Office Society

Third Award - American Society of Civil Engineers

#INFLUENCE OF SOIL CONTAMINANTS ON SEED GERMINATION

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This research project was carried out to determine the effect of soil contaminants on the germination of a major agricultural crop (wheat). A great deal of public concern has been expressed in the last few years on the impact of toxic substances upon the environment. While extensive research has yielded much data on the hazards to animal life, there is a need for this same information concerning plant life and future plant life (seeds).

Soil contaminants for this study were selected on the basis of recent public concerns and included: heavy metal ions (mercury and lead), organic hydrocarbons and solvents, and various salts and polyatomic ions.

The procedure involved placing seeds in petri dishes containing an absorbant paper. The appropriate test solution was added to each petri dish to wet the filter paper and seeds. The number of seeds to germinate was determined each day. Several variables which might affect germination were carefully controlled: lighting conditions, temperature, pH, and concentration of ions. To increase confidence in data and conclusions, the averages of three 50-seed trials were plotted for each test condition.

Analysis of data revealed that a number of substances such as nitrate, sulfate and phosphate ions do inhibit seed germination. Lead and mercury ions turned out to be very powerful inhibitors. The organic solvents benzene and trichloroethylene, very surprisingly, had no effect.

#Fourth Award - General Motors ISEF/Environmental Sciences

TWO YEAR STUDY - "NUCLEAR WINTER: FACT OR FANTASY"

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In the second year of my project, I attempted to determine what effect, if any, nuclear winter would have on the rate of photosynthesis. To measure this, I used the floating leaf disk assay of photosynthesis which is based on the flotation of submerged, infiltrated leaf disks. Using disks of leaf tissue which had been vacuum infiltrated in order to replace intercellular air caused the disks to sink in a dilute buffer solution. As photosynthesis occurred, the oxygen produced accumulated in the leaf disks causing buoyancy. By using 1/ET50% as the index for measuring the rate of photosynthesis, I collected data on the photosynthesis rate in a controlled environment with water as a light filter. The second stage involved repeating the photosynthesis assay in an experimental, nuclear winter environment created by burning samples of ever present materials in the environment.

The average ET50% was 11.6 minutes in the controlled environment and 40.6 minutes in the experimental environment. This gave me a calculated difference of 71%. The average rate of photosynthesis in the controlled group was .0862, while the experimental group was .025. By comparing the data collected in the two experiments, I determined that the rate of photosynthesis would decrease by an arbitrary difference of 71%. This was derived by subtracting .025 from .086 which gave me .061. I then divided .061 by .086 which gave me my 71% arbitrary difference.

Therefore, I concluded that nuclear winter is more of a fact than a fantasy. Our future could very easily be a "NUCLEAR WINTER".

AN ASSAY OF MICROBIAL DEGRADATION OF PHENOL IN AERATED SOIL

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One of today's major environmental concern is the large number of manmade organic compounds, such as phenols, reaching the soil as a consequence of the activities of modern industry and agriculture, and by remaining there for various periods of time have caused concern to society. There are no universal methods to ultimately eliminate the potential dangers of industrial emissions of phenol as waste products or accidental spillage and seeps which will bring phenol to soil in certain locations. However, studies have shown that a feasible process for soil recovery is microbial degradation. This study focused on the assay of microbial degradation of phenol in aerated soil. This study is divided into two different phases. An experimental apparatus was constructed for each phase. The experimental apparatus included nine flasks containing separate soil samples through which filtered air was distributed in order to supply soil microorganisms with the necessary oxygen. Samples were taken from each flask when necessary and were later analyzed using a Beckman High Performance Liquid Chromatograph. Results of different levels of phenol breakdown from the soil samples were averaged together to achieve a median range of the different stages of phenol degradation in the experimental phases. Careful examination and detailed observations of the experimental aparatus and data indicate that there is indeed microbial degradation of phenol in aerated soil. Even though this research perains to soil, it may also be applied to the aquatic environment based on the assumption that microbial metabolism is generic, or its metabolism is the same in soil as in water.

A SOLUTION FOR THE SAN JOAQUIN VALLEY FARM LAND DRAINAGE WATER PROBLEM

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Irrigation drainage water from the San Joaquin Valley farm land contains selenium and other impurities which are harmful to our environment. An investigation was made to solve the problem that the polluted irrigation water presents. The investigation involved removing these harmful impurities by using new technology in pre-treatment and reverse osmosis. In order to remove the selenium and other salts, the drainage water had to be pre-treated and then run through reverse osmosis modules. A working model of this procedure was built and tested in order to demonstrate how this could be accomplished practically on a larger scale. This model consisted of seven basic stages of water treatment. First, the drainage water was injected with alum, a polymer, and chlorine. Then, the turbity was reduced by 95% with a new method of clarification using a contact clarifier. The water then was filtered through a sand filter which removed 99% of the remaining turbidity. After this, it was run through an ion exchange medium to remove calcium and magnesium to prevent fouling of the reverse osmosis membrane. This was followed by passing it through a carbon filter to remove the chlorine which can also foul the reverse osmosis membrane. The water was then passed through reverse osmosis modules to remove the remaining impurities including selenium. My system reduces the turbidity from 90 to under .3 and reduces the dissolved solids from over 5,000 to under 500 pounds per every million pounds of water. By using my method it is possible and practical to save our environment while keeping our farm land in production.

#THE EFFECT OF FERTILIZER RUN-OFF ON POND ECOSYSTEMS

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My experiment was set up to establish the effects of fertilizer run-off on pond ecosystems. I predicted that the fertilizers would inhibit the pond fauna while stimulating the flora. To test my hypothesis, I established two sets of simulated ponds. Each contained equal amounts of duckweed and elodea and two planaria, daphnia, amphipods, brown hydra and pond snails. To facilitate ease in determining any effects upon the pond life, I constructed ponds rather than using actual pond water. Above each pond was a funnel, containing Rye grass, which I grew in soil. I watered these with fertilizer solutions, twice a week. The solutions then percolated down into the ponds, simulating fertilizer run-off from fields and lawns. Agriculture, lawn and house plant fertilizers were used in concentrations of 100%, 10% and 1%. My controls were watered with distilled water. The pond life was observed once a week for 4 weeks. My research indicates that fertilizers are harmful to pond ecosystems and higher concentrations are inhibitory to both the plant and animal life. Although lower concentrations of fertilizer did stimulate the plant life, it eventually caused blooms of algae in one set of ponds, which decayed and used up the oxygen in the ponds. Very few creatures, besides snails, lived throughout the testing period in the fertilizer solutions, while in the controls, the plant life thrived and the invertebrates multiplied. Upon comparison of the fertilizer contents and the results of my tests, I discovered the agriculture fertilizer was least harmful, which I believe, is due to the nitrogen content.

#Fourth Award - General Motors ISEF/Environmental Sciences

HOW DO SULFURIC AND NITRIC POLLUTANTS AFFECT FOLIAGE?

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In this project my primary objective was to test , prove , and demonstrate the damaging effects of acidic pollutants on foliage. My hypothesis was that both sulfuric and nitric pollutants are harmful to foliage but nitric acid is somewhat neutralized by the soil and therefore may not be as harmful as sulfuric acid. I tested these common acidic pollutants through four separate experiments. In the first experiment I tested the application methods of the acids to determine the best way to simulate polluted precipitation. Three means of application were tested: a narrow (stream) spray , a wide angle spray , and directly through the water source. At the end of the first experiment , I concluded that the best way to simulate rainfall and demonstrate the effects of acid pollutants was through application of the acids by a wide angle spray. In the next three experiments I tested the effects of sulfuric and nitric acids both separately and combined. I concluded that the plants that had a sulfuric acid application had approximately 10% more plants to die than those plants that had a nitric acid application.

Overall , each experiment had a total of forty-eight plants divided into four groups of twelve , one of which was a control group. The testing period for each experiment was twenty- eight days. The ph level of both the sulfuric and nitric acid was approximately 4.5. Lastly , the overall health of the plants was judged by leaf and stem discoloration and growth.

#THE EFFECTS OF CHANGING ELECTROMAGNETIC RADIATION ON AN ECOSYSTEM

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Today, radio is the foundation of society. Through its exploitation, however, our environment is being exposed to billions of watts of unnatural low frequency radiation. This is especially true of frequencies below 2 KHz. By establishing an aquatic ecosystem, a long aquarium filled with goldfish, I was able to expose fish to a strong source of ELF electromagnetic radiation, similar to the type produced by high power transmission cables. All forms of bias were removed from the system before the experiment, prior to testing. Using a video camera to record data, a micro-computer, and a means of creating a composite image, I could convert observational information from the VCR tape into numerical data locations stored in the computer. Utilizing computer generated scattergrams and statistical information overlays, a computer graphics data analysis was established which could provide conclusive evidence of a definite effect upon the equalibrium of the ecosystem. Correlations between corresponding testing groups were also possible using the graphic analysis. The ELF radiation had at first repelled the fish, but they had apparently adjusted over a 24 hour period. All that remained was a predominant migration to the surface of the water, similar to the moon's effect upon fish. Perhaps, based on research done on humans, reported by Dr. John Cameron University of Wisconsin, the ELF radiation had placed the fish in a feeding mode. Because the results of this piece of research were so definite, one could conclude that there is a definite effect on our ecosystem from radio transmissions. And, because radio has had such an impact upon our society, further study into the possible positive and negitive effects of such radiation is imperitive.

#First Award - Federal Aviation Administration
Third Award - General Motors ISEF/Environmental Sciences

ACIDIFICATION OF A NORTHERN MINNESOTA LAKE: THE BEHAVIORAL AND MORPHOLOGICAL EFFECTS ON *DUGESIA DOROTOCEPHALA*

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Water from Carrot Lake in northern Minnesota was acidified, using sulfuric acid, to a pH similar to that found in mildly acidified lakes. The feeding behavior of the planaria, *Dugesia dorotocephala,* was studied in normal lake water and in acidified lake water over a period of 14 days, for four feeding sessions. Specimens from both groups were prepared for study with a scanning electron microscope, and the morphology of the anterior sections was studied on a blind basis. This study found a correlation between changes in feeding behaviors and morphology, showing a harmful effect of an acid environment on planaria. Food finding efficiency decreased for planaria in water at pH 5.9, a pH level slightly above the lethal level for planaria in unbuffered lake water. Study of microstructures of the anterior portion showed no change in the chemoreceptors, but did reveal that there were more new or growing microvilli and auricular epithelial cilia. The microvilli on the auricles were much more dense on the planaria in the acidified environment. This could indicate that planaria tried to compensate for their loss of efficiency by growing more microstructures, but the efficiency remained low. From this study, it appears that acid rain poses a threat to planaria.

THE TOXICITY OF PESTICIDES AND LOCAL WATER SAMPLES ON THE RATE OF OXYGEN PRODUCTION DURING PHOTOSYNTHESIS

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Time is running out for many water bodies across the United States. As exemplified by the Chesapeake Bay and local recreational lakes, much of this pollution is a result of agricultural and domestic run-off water and sediments from construction sites. With this ecological impact in mind, it was hypothesized that pesticides and local water samples would hinder oxygen production during photosynthesis in Anacharis.

As a preliminary for each of the 3 phases conducted, 3 groups of 5 tubes, each containing one 8 cm. sprig of Anacharis and 50 ml. of water at 25°C. were used. In phase I of this investigation, the optimum light and temperature intensities for maximum oxygen production were established. During phase II, the tubes were filled with 50 ml. of 0.1%, 1.0% and 10.0% concentrations of pesticides and exposed to 1500 lumens of light, at 35°C., as established in phase I. Phase III consisted of exposing sprigs of Anacharis to 50 ml. of local water samples at 1500 lumens of light, at 35°C. All 3 phases were subjected to 75, 3 minute trials during which oxygen production was measured.

From the results obtained, as light intensity increased from 350 to 1500 lumens, the oxygen production increased. It was observed that oxygen production was inhibited by extreme temperatures of 0°C. and 100°C. Phase II results suggested that increasing concentrations of pesticides cause a decline in the oxygen production. Polluted local water samples adversely affected oxygen production.

It can be concluded that as pesticide concentrations increase, oxygen production decreases. In the studies of local water samples, oxygen production was inhibited the most in Lake Luxembourg and the least in Silver Lake. If man continues to pollute his environment, our aquatic resources will fail to meet the needs of all forms of life.

# AN ANALYSIS OF WATER-SOLUBLE INTERNAL COMBUSTION EMISSIONS AND THEIR EFFECTS ON BACTERIA OF THE HUMAN RESPIRATORY SYSTEM

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Trying to reduce the amount of pollution in the air, Indiana has mandated an automobile emission testing program. However, the tests only take into account the car's age and its emitted hydrocarbons; neither fuel type nor any other emissions are considered. The objective of this research was to prove that different fuels have different effects on the human respiratory system. This was accomplished through testing different water-soluble automobile emissions on five commercially-obtained bacterial species common to the human mucous membrane.

Experimentation revealed that nitrate and sulfate ions present in the emissions were detrimental to the bacteria. Furthermore, a low pH accompanied those solutions that most inhibited bacterial growth. Some emissions with high concentrations of sulfates were countered by the beneficial actions of the phosphate ions present. Those emissions with high concentrations of nitrates, sulfates, and a low pH were the leaded, premium ethanol, and unleaded gasolines, which, respectively, were the three most detrimental fuels. Premium gasoline, on the other hand, was the least detrimental fuel and contained the least amount of nitrates and sulfates. This research has proven that different fuel emissions have different effects on bacteria of the human respiratory system.

#Second Award - General Motors ISEF/Environmental Sciences
Alternate - U.S. Department of Energy

THE POLLUTING OF A LAKE

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Last year the coliform levels at the bathing beach at Lakes Park exceeded the state standards for public bathing beaches four times. Coliform contamination was noted in a study done by this researcher last year. The researcher collected eight water samples from the tributaries leading into Lakes Park and several sites within the park and compared them to the coliform levels in the designated swimming area. The researcher performed a presumptive test on each of the eight samples and a control of sterile distilled water using a three tube MPN test with single and double strength lauryl tryptose broth. Cultures showing gas production in the lauryl tryptose were transferred to brilliant green broth for the confirmed test. Any sample with gas formation in an inverted Durham tube in both lauryl tryptose and brilliant green broth constituted confirmation of coliform contamination. Subsequent testing including inoculation into EC broth provided differentiation between fecal and non-fecal coliforms.

From the initial investigation conducted, it appeared as though the tributary leading into Lakes Park that passed through the greatest concentration of people had the highest coliform contamination. Additional sampling of the same points confirmed the results of the initial investigation. The drainage ditch that the researcher called trailer park ditch had the highest coliform contamination. Tip Top Trailer Park and the 8 Ball Lounge are both located along this drainage ditch. The second test included additional samplings of trailer park ditch. Coliform counts in three of these samples surpassed 1100 MPN. It is possible that one or both of the establishments on this ditch are polluting the water through their septic or waste disposal systems.

DO LEACHED METALS AFFECT AQUATIC BIOTA?

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In nature, atmospheric moisture becomes acidified when pollutants are released by internal combustion engines (automobiles, trucks, etc.) and industrial centers (fuel refineries, steel mills, etc.). These pollutants combine with water vapor to form sulfuric and nitric acids. When these acids are precipitated onto our land and waters, they leach heavy metals from the soil and bedrock. The objectives of my research were to determine the acute effects of: 1) water acidified with these acids on chinook salmon (*Oncorhynchus tschawytscha*) and brown trout (*Salmo trutta*) and 2) leached heavy metals (aluminum and lead) on brown trout.

The data from my studies indicated sulfuric and nitric acids diluted to a pH of 2 or 3 are highly toxic for salmon and trout fry and fingerlings. At pH 4, diluted sulfuric and nitric acids were highly toxic for salmon fry and less toxic for salmon and trout fingerlings and trout fry. When the two acids were combined (1:1), the acidified solution was substantially more toxic than either acid alone for trout fry. For salmon fingerlings, the combined and individually tested acids were non-toxic. At pH 5, 6 and 7, the diluted sulfuric and nitric acid solutions were slightly or non-toxic. Concentrations of 1000 and 100 parts per million (ppm) of aluminum or lead in acidified water (pH 4.0) were highly toxic for brown trout fingerlings. At the 10 and 1 ppm levels, aluminum was found to be more toxic than lead. At 0.1 ppm, both metals were non-toxic (had no acute effects). In contrast, the 1 and 10 ppm levels of aluminum or lead solubilized in non-acidified water (pH 7.0) were found to be non-toxic.

CAN BACTERIA TOLERATE LIMONENE AT INCREASING CONCENTRATIONS?

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The purpose of this experiment was to determine if *Escherichia coli* and *Staphylococcus epidermidis* would tolerate limonene in various concentrations.

In the first phase of the experiment, I performed a Klett Reading test. I took 10 ml. of chosen liquid media, which was either nutrient broth or minimal media. This was then placed into a Klett flask. The various concentrations of Limonene were chosen along with a control flask. These tests were run approximately seven hours. Readings were taken every 15 minutes for a 7 hour period of time. The flasks were kept in a water bath shaker between Klett readings.

The second phase of the experiment was a viability test. This is a dilution factor test. The dilutions are made with suspension media. The bacteria are grown into stationary phase overnight. While the bacteria are in the stationary phase, I took two 125 ml. flasks and placed 5 ml. of bacteria in each. In one flask, I pipetted 200 microliters of Limonene. These flasks were placed in waterbaths between tests. There was a test run every 2 hours for 12 consecutive hours. The tests consisted of dilutions that were later placed on petri dishes. These petri dishes were then placed into a incubator for 12 to 18 hours. Bacteria colonies were then counted and the average determined.

My results indicate that Limonene is tolerated by Gram negitive and Gram positive bacteria. This researcher will continue to explore ways in which Limonene may possibly be used as a natural bio-degradable pesticide.

MATHEMATICS

#FRACTALS!?

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Fractals!? The word was founded only in 1975 by Dr. Benoit B. Mandelbrot. He is the foremost fractal pioneer today and defines the term as "a set for which the Hausdorff Besicovitch dimension (fractional dimension) strictly exceeds the topological dimension. There are many uses that fractals can and will be applied to. Mathematical modelers can use them to simulate shoreline decay and its effects on fisheries. Biochemists can use fractals to characterize the irregularity of protein surfaces and its influences on molecular interactions. John Wheeler professor of physics offers that no one will be considered scientifically literate tomorrow who is not familiar with fractals! The concepts and methods the set is based on, comes from the ideas of several mathematicians who worked between 1875 and 1925 on irregular shapes. Simply put, the Mandelbrot Set, a special fractal, is the set of all complex numbers C for which the size of $Z^2 + C$ is finite even after an indefinitely large number of iterations.

#Second Award - U.S. Air Force

EXPLORING THE BOUNDARIES OF THE MANDELBROT SET

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Fractals describe a new geometry of nature. They form a field of mathematics that may have a profound impact on how we view the world, not only in art and film but in many branches of science and technology, from astronomy to economics to predicting the weather. Euclid's lines, planes and spere's describe the world of man made things. Fractals describe the chancy intricacies of nature. They are a family of irregular shapes with just enough regularity so that they can be mathematically described. Magnify a fractal again and again and more detail always emerges. Each part of a fractal is like the whole. The purpose of my project is to generate fractal images using a simple formula to represent the Mandelbrot set. The Mandelbrot set lies at the center of a vast two-dimensional sheet of numbers called the complex plane. When a certain operation, $Z=Z^2+C$, is applied repeatedly to the numbers, the ones outside the set flee to infinity. The numbers inside remain to drift about. After establishing the fractal image, I enlarged the area close to the boundary of the Mandelbrot set, where an infinite regress of detail is found. Although the programs I used took a long time to produce the fractal images, I felt that they produced adequate results. There is much to be learned about the world of fractals and I hope to continue my explorations with them.

AN INVESTIGATION OF POLYHEDRONS AND POLYHEDRAL NUMBERS IN RELATION TO POLYGONS AND POLYGONAL NUMBERS

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The objective of this project is to comprehensively study polyhedrons and polyhedral numbers and their relationship to polygons and polygonal numbers through discovering any similarity between the general polygonal formula and the derived polyhedral formula.

The first step in conducting research was the extensive study of the topic through library books, school teachers, and mathematics periodicals. Pertinent mathematical terms concerning polygons and polyhedrons were then defined, and the purpose of the project was stated. The following step involved creating tangible models of polyhedrons for polyhedral number determination. The next step concerned mathematically proving that only the five known regular polyhedrons exist. The main step in the research project involved taking the general polygonal formula $(T_N = N/2[(V-2)N-(V-4)]$ and using it to derive a general polyhedral formula:

$$(T_N = N/6[AN^2+[3(V-2)-3A]N+[2A-3(V-4)]])$$

Through this formula, any polyhedral sequence term could now be determined. It was discovered that the polygonal formula is a special case of the polyhedral formula. To expedite the use of the polyhedral formula, a computer program was designed to generate polyhedral numbers for the five known regular polyhedrons. This program was expanded into a polyhedron teaching device.

As an end result of my research, a greater understanding of mathematical logic, induction, and formula derivation was obtained. An increased knowledge of three-dimensional objects was also realized. The formulation and research tied together algebraic and geometric processes to achieve a general formula for polyhedral numbers.

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* ANALYSIS OF SUMS OF DIGITS CUBED FOR INTEGERS FROM 0-10,000

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If one takes any whole number, squares the digits adds them, does the same to the sum and continues the process, one will always come to 1 or 89. Both of these numbers are prime and Fibonacci numbers.

This leads to the question: Is there a set of prime, Fibonacci numbers which satisfies the relationship for the sum of the cubes of the digits?

This study indicates that there is not a set of prime, Fibonacci numbers, however, there is a set of repeating numbers that satisfies the relationship for cubed digits.

Data analysis reveals that the digital base of an integer is an important predictor for the third power repeating numbers.

CONJECTURE 1

If the digital base of a positive integer is[1, 4, or 7, then the sum of the cubes of the digits will be either 1,370,(133,55,250), (352,160,217),(1459,919), or (136,244)].

CONJECTURE 2

If the digital base of a positive integer is 2, 5, or 8, then the sum of the cubes of the digits will be either 407, or 371.

CONJECTURE 3

Most importantly, if the digital base of a positive integer is 3, 6, or 9, then the sum of the cubes of the digits will be 153.

#Fourth Award - General Motors ISEF/Mathematics

#ANALYTICAL AND EXPERIMENTAL STUDY OF MINIMAL LENGTH NETWORKS

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As defined by graph theory, a tree is a connected network of line segments that contains no circuits. This network can be shortened using additional points called Steiner points and forming a Steiner tree. The number of Steiner points necessary for a minimal length network is n-2, when n equals the number of primary points. Steiner trees and soap films, that always seek a minimal area because of surface tension, adhere to the same rules.

Reported is the results of analytical and experimental work in which a basic algorithm, which incorporated a row and column search pattern and direct application of Pythagorean's Theorem, was used to model the behavior of two-dimensional soap films. Using this algorithm, the location of the Steiner point for a network with three primary points, was computed. The calculated points were compared to the measured location of the Steiner intersection of two dimensional films confined between plastic plates. Eighteen cases were examined where position of the primary point pins and the angle between the two plates that confined the film were variables.

A second algorithm was developed for three primary points, based on a geometric construction. The new algorithm substantially decreased the computer operating time and improved the accuracy of the location of a Steiner point and the minimum length tree formed.

The models were found to accurately predict the actual positioning of the Steiner point for horizontally oriented test fixtures. Since the frames were held horizontally, gravitational effects were not substantial and therefore were not part of the calculations. Also, because of its small effect, film viscosity was not considered. The experimental data comfirmed that these variables have no significant effect.

#Fourth Award - General Motors ISEF/Mathematics
Honorable Mention - National Aeronautics and Space Administration

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MEDICINE DOSAGE: TOO MUCH OR TOO LITTLE

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Given a patient whose minimum amount of medicine is 10 cc of active chemical and whose maximum is 12 cc, the medicine dosage that should be prescribed for the patient can be determined through the use of probability and linear algebra.

Medicines contain mostly filler and a small amount of the active chemical. Tolerance is used in medicines to tell the doctor what the range of active ingredient is. After mathematically deriving several equations applicable only to linear functions, these equations were displaced by further, more complex equations which were obtained through computer programming, due to the complexity, and which apply to more various situations.

These new equations were developed by combining geometry, medical algorithms, mathematical algorithms and using computer science to interweave the three subjects successfully to obtain maximum and minimum dosages the fall safely within the patient's limits.

The expected value of medicine A multiplied by the quantity prescribed for the patient plus the expected value of medicine B multiplied by the quantity prescribed should equal the average of the patient's minimum and maximum.

A TWO-YEAR STUDY OF NEW FORMULAS FOR COMPLEX PENDULUMS

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This study was performed to find a working equation for a pendulum that has its pivot point changed during the middle of its period or that has multiple masses on the string. By using the standard equation $(2\pi(L/g){}^\wedge.5)$ as a base I hope to find equations that will work for these pendulums.

The first pendulum used had a bar placed across the path of the string so that the string hit the bar during the middle of the period. After observing the pendulum for a while, I noticed that the pendulum had a changing pivot point and that half the period was of the length from the pivot to the mass, and half the period was of the length from the bar to the mass. The standard formula was then modified to $(\pi\sqrt{(L/g)}+\pi\sqrt{(L2/g)})$, with L being the length from the pivot to the mass and L2 being the distance from the cross bar to the mass.

The second pendulum had two masses placed on the string in different locations. I considered the distances between the two masses as one mass and found the center of gravity to derive the formula $(2\pi(pm+(m1*1b)/(m1+m2)){}^\wedge.5$.

I then tested these formulas by writing a computer program to calculate the periods and other variables. I took ten tests of each of the ten trials. Each trial consisted of timing the pendulum for ten swings then dividing the time by ten. I averaged the ten periods and used this for the experimental value. I then used my formula to find an accepted value. By using the accepted value found by the computer and the value from the experiment, the computer calculated the percentage error. After finding the low percentage errors using both formulas, I feel my formulas are correct.

THE SLOPE DETERMINATION OF ANY SIDE OF A REGULAR POLYGON

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This project concerns the development of a mathematical formula to compute the slope of any given side of a regular polygon. This formula was discovered through a simple and logical process. The graphs of six polygons were constructed on graph paper, then, by using the interior angle theorem and basic trigonometry, the slope of each side of the figure was computed. It should be noted that due to the positioning of the figures (parallel to the x-axis), the slope of the base line will always have a value of m=0. After attempting this process on a nonagon, it was decided that the process was both too difficult and too cumbersome to accomplish the task efficently. At this point, it was thought that utilization of the tangent function might prove fruitful. After a thorough search of available geometric texts, it was concluded that the measure of the exterior angles of the polygon could be used to determine the reference angle of the polygon side, and thus determine the slope.

#A DISCOVERY OF SUPERSEDING VALUES AND THEORY FOR THE NONCOMPUTABLE $\Sigma_n(K)$

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This project is an investigation into noncomputable functions, a fundamental concept in theoretical mathematical logic, with applications in computer science. The function under consideration here, Professor Rado's $\Sigma_n(k)$, is defined as the largest finite number of identical symbols produced along a linear tape by a $T_{n\cdot k}$ Turing machine with an n-symbol alphabet. A complementary function, $S_n(k)$, is the maximum number of shifts before halting. While both functions were proven generally noncomputable, the values for small n and k can be found through exhaustive investigations of all possibilities.

The difficulty lies in the large (and extremely rapidly increasing) number of variations to be investigated in determining a given value, as well as the large number of shifts before halting (and resultant difficulty in determining finitude) for each variation.

In work on the 3-symbol, k=3 problem, I wrote a computerized program which incorporates high-efficiency search techniques I devised, to minimize the variations searched. I discovered values for $\Sigma_3(3)$ and $S_3(3)$ of 16 and 74 respectively, which supersede the previously recognized values of 12 and 41. In my further work, I found the value of $\Sigma_3(2)$ to be 9. This discrepancy with the value $\Sigma_2(3)=6$ lead me to conclude that, for a constant n·k, a higher value of n (the number of symbols) yields a higher value of $\Sigma_n(k)$. Data patterns I have found strongly support this, and explain several fundamental theoretical questions raised by my research. I am currently researching the $\Sigma_4(2)$ problem for comparison with $\Sigma_2(4)=13$.

Since Turing machines represent the fundamental model for all digital computers, my findings may have significant bearing on computer design and efficiency.

#Second Award - General Motors ISEF/Mathematics
Second Award - Mathematical Association of America

PATTERN RECOGNITION OF STATE VARIABLES WITH FRACTALS

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This study was undertaken to test the hypothesis that computer generated patterns, called fractals, could be used to amplify subtle changes of state in a complex system. The basis for this study was the application of the newly developed complex number mathematics called Mandelbrot Geometry. Microcomputers were programmed in Basic and Turbo Pascal to develop fractal generators which were stimulated by sensor data from several complex systems. Hypothetical behavior of ammonia at various temperatures was represented with fractals. Annual oceanic data from Puget Sound was also traced using fractals, which emphasized the normal seasonal cycle. Artificial data from highly sensitive mechanisms are currently being attempted. Sixteen Tandy microcomputers were utilized simultaneously to perform rigorous calculations and data management techniques were adopted to save the generated patterns. The resulting changes in fractal patterns were observed. Results indicate that subtle changes in a dynamic system can be monitored and amplified using fractals. Incipient failure detection can be an important application.

A STUDY OF QUASAR, STAR, AND TRIANGULAR NUMBERS IN FOUR DIMENSIONAL SPACE AND BEYOND.

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Figurate Numbers are positive integers expressing the number of dots in various geometric, "figurate" patterns. This research extended previous research and determined Four and Five Dimensional Figurate Numbers as well as corresponding generation formulas and properties for such. The researcher also developed series' of Trans-Dimensional Figurate Numbers in each number type.

I. (Previous Research) Figurate Numbers were defined and formulas were developed and proved in One, Two, and Three Dimensional Space for various standard geometric figures.

II. Figurate Numbers for each type of figure in Four Dimensional space were defined, determined, and listed by the researcher. Then, a formula for the generation of these numbers was proposed and proved, as well as theorems concerning closure, divisibility, and evenness and oddness patterns.

III. The Four Dimensional Figurate Number definitions were extended into Five Dimensional Space by the researcher. Again, the Figurate Number types were defined, listed, and a formula for the generation of these numbers was proposed and proved. Various theorems concerning these numbers were developed and proved by the researcher.

IV. Once the Four and Five Dimensional studies were completed, a study of the formulas for the generation of each figurate number type in dimensions one thru five was undertaken. As a result of this further study, a Trans-Dimensional formula for the generation of each Figurate Number system in the N^{th} Dimension was proposed and proved.

#FIBONACCI EXTENSION

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FIBONACCI EXTENSION is the second part of a two year exploration of the various aspects of the Fibonacci Number Sequence, while seeking a unique approach to proving the completeness of this system.

The main purpose was a quantitative comparison of the Fibonacci and Lucas numbers, the two most frequently used sequences of the recursion formula, $R_n = R_{n-1} + R_{n-2}$, while using $R_1 = 1$, $R_2 = 1$, $R_1 = 1$, $R_2 = 3$.

The secondary purpose was an analytical approach to the Fibonacci Number Sequence and how it applies to biology, phyllotaxis, other number functions, and the Golden Ratio used in art and architecture. Through my research, I have concluded that Fibonacci numbers have a wide variety of applications from mathematical computations to patterns in architecture and nature.

I developed original theorems and proved them through mathematical induction, and while attempting to prove the completeness of the Fibonacci Sequence, I developed an original method which I termed "Fibofrictions."

#First Award - U.S. Air Force

TRINOMIAL EXPANSION & TRIBONACCI DERIVATIVE

Mootha, Vamsi K.
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PURPOSE: The purpose of this project is to develop a pattern of numbers similar to Pascal's Triangle which will enable a user to expand any given trinomial to any desired power.

PROCEDURE: The researcher examined Pascal's Triangle and used his analyses in experiments in which he tested new sets of coefficients and methods of variable and sign distribution.

RESULTS: The student produced a set of numbers assuming the general form of a tetrahedron, in which the coefficients of each degree exist in the triangular levels of the pyramid. The student also developed a general formula for the coefficients of the tetrahedron. Finally, the researcher made a finding which was not one of the original goals of the project. When researching, the student learned of how Fibonacci's Sequence is derived from Pascal's Triangle. Using this correlation, the student derived a similar series of numbers from the newly developed tetrahedron.

CONCLUSIONS: The student was quite successful in accomplishing his goals. Trinomial expansion via the newly developed tetrahedron seems far less tedious than the conventional method of expansion. In addition, the researcher observed that both the new tetrahedron and Pascal's Triangle are based on the principles of ratios, combinations, and, to an extent, even permutations. Finally, it is the hope of the researcher that the new tetrahedron and the method of trinomial expansion developed in this project will have great use in the various fields of mathematics which currently use Pascal's Triangle.

HOW CAN THE SUN HELP US TELL TIME?

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My project's purpose was to find the angles of the shadow from the noon line by setting up a "simple" sundial, and make sundial that fits for local area. To do that I had to place a rod on a leveled surface, and find the noon line by drawing a circle, using the rod as a center. In the morning, watch until the tip of the shadow of the rod exactly touches the circle and mark the place and again when the shadow's tip just touches circle in the afternoon, and find the mid-point, which becomes the noon line, or the true north. The next day go out every fifteen or thirty minutes and find the length of the shadow, time of the day, and the angle from the noon line. Results showed the length of the shadows were getting shorter each day which showed me that summer is getting closer. Also showed that each hour was 15° apart from each other. When I graphed the data it came out to be the parabola. So by extending my data, I found that taking winter and summer curve together makes hypolabola. And because of the sun's declination on any day we can draw the line of declination for that day so that our dial will serve as a calendar to tell the day of the year as well as a timepiece to tell the time of the day.

# APPLICATIONS AND THEOREMS OF HYPERCUBES AND LATIN HYPERCUBES

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The fourth dimension has been a vehicle for speculation at least since the 19th century. The idea of a fourth, physical dimension culminated in Einstein's theories of special and general relativity; space and time together make up a four-dimensional continuum in which all real events are timelessy frozen. This view of the universe may be undergoing dimensional modifications; the so-called Kaluza-Klein theory adds seven more dimensions in the form of miniature hyperbubbles attached to every point in spacetime.

These theories, however, do not speculate on the shape of the higher dimensions (fourth dimension and up). It is easy to imagine a three-dimensional object; we see them everyday. But trying to comprehend a four-dimensional object is next to impossible. The human's mind has been conditioned to only visualize in three dimensions, but the work of math tells us there are many more dimensions.

Research on the shape of the fourth dimension has been varied and contains many theories. A computer can now simulate a four-dimensional cube, but the human eye is unable to comprehend this extra dimension. This project answers the following two questions:

1) What are the theorems, definitions, equations, and reference systems that apply to the higher dimensions?

2) Do higher dimensional Latin Hypercubes retain the same properties as the lower dimensional Latin squares and cubes, and what are some of the practical aspects of the Latin Hypercube?

#Third Award - General Motors ISEF/Mathematics
Third Award - Mathematical Association of America

# A NOVEL APPROACH TO THE "3x+1" PROBLEM

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The "3x+1" has been an unsolved problem for almost sixty years.

It is called the "3x+1" problem because of the recursive function f. If x is a positive integer, then

$$f = \left[\begin{array}{l} 3x + 1, \text{ if } x \text{ is odd} \\ \frac{x}{2}\ , \text{ if } x \text{ is even} \end{array}\right. \text{ and } f^{(n)}(x) = f\left[f^{(n-1)}(x)\right],\ n \epsilon J^{+}.$$

The conjecture is that repeated interations of f will eventually yield 1, or $f^{(n)}(x) = 1$ for some $n \epsilon J^{+}$. I have developed a new function $g^{(n)}(x)$, which represents the nth odd integer encountered in taking iterations of f. I have shown that $g^{(n)}(x) \sim 1$, or $g^{(n)}(x) = 1$ for some $n \epsilon J^{+}$. Therefore $f^{(n)}(x) = 1$ for some $n \epsilon J^{+}$ and thus the "3x+1" conjecture is proven.

#Scholarship - U.S. Marine Corps
Third Award - General Motors ISEF/Mathematics
London International Youth Science Fortnight Trip - U.S. Navy/NORDA

COMBINATORIAL APPROACH TO THE SIEVE OF ERATOSTHENES

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The main concern of this research is to transform the Sieve of Eratosthenes into a mathematical equation to describe the relationship of prime numbers. As a result, a combinatorial formula is developed from principle of the sieve method. The formula yields the sum of primes less than or equal to given integer u when primes less than or equal to squareroot of u are given. The sequence of all odd primes may also be generated from the formula.

The fundamental concept of the combinatorial formula is rather simple: when the sum of composites are subtracted from the sum of natural numbers, the result is the sum of primes. Simpler process of the Inclusion and Exclusion Principle is also reflected on the formula.

A discussion is included of possible applications of the formula regarding the theory of prime numbers. The applications include pi function, twin primes, and examination of primeness.

#LUCAS-SIGMA SEQUENCE RELATIONSHIPS

Gaidos, Glen

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The group of sequences named Fibonocci, Tribonocci, Tetronocci, etc. can be given the general term "Sigma" sequences. Lucas sequences and Sigma sequences both recursively generate their values, but in the Lucas sequence, there are no restrictions on the initial values. Relationships between the sequences can be established by mathematical induction. A generalization of these relationships is then proven. The generalization can then be applied in the determination of Lucas sequences by the solving of simultaneous equations.

#Fourth Award - General Motors ISEF/Mathematics

# ALGORITHMIC METHODS FOR GENERATING REVERSAL SUMS

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The purpose of this project is to devise methods for generating "reversal sums" - pairs of equi-digit numbers whose sum is equal to the sum of the reversals of the numbers - e.g. 3657 + 9675 = 5769 + 7563. Reversal sums have been evaluated in modulos 3, 9 and 10, and equations developed herein, to generate such sums. Additionally, an algorithm has been constructed which not only generates all n-digit reversal sums, but also facilitates their production. From this algorithm, it has been discovered that whenever an n-digit palindrome, a number which reads the same both forwards and backwards, is added to an n-digit number, a reversal sum will result - e.g. 542 + 222 = 764; thus, 542 + 467 = 245 + 764. No known previously published literature exists on this topic.

#Second Award - General Motors ISEF/Mathematics

A TWO YEAR STUDY OF MATRIX PROBABILITIES: OUTCOME MATRICES, MARKOV CHAINS AND TRANSITION MATRICES

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The first portion of my project deals with the standard rules and associated equations for making probability studies. This includes an in depth look at general probability theory in relation to outcome matrices, (matrices of varying orders with entries corresponding to possible outcomes E1, E2,...,En-1, En, of a given system in which the probability of obtaining a specific outcome can be denoted by a single probability pk) markov chains (systems where probable outcomes of a trail, n, depend on the outcome of the directly preceding trial, n-1 and each outcome pair, (Ej,Ek), has a corresponding conditional probability pjk) and transition matrices (matrices with entries ajk which correspond to the probability of the transition, pjk, between every state Ej and state Ek). These systems are then used to chart the hidden probabilities found in the Parker Brothers game, Monopoly. This involves the creation of a 41 x 41 transition matrix containing the probability of transfer from every square to every other square. This matrix was raised to the 35th power resulting in a constant probability matrix. The third goal of this study was the writing of a computer program that uses the resulting positional probabilities to show how every action taken by a player will directly affect the probable outcome of the game. The mathematical systems of this study can be applied to other mathematical, scientific and technology based systems including genetic studies and military simulations.

THE SOLUTIONS OF AX + BY = C AND ITS IMPROVEMENT

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A great many puzzles, riddles, and trick questions lead to Diophantine Equations whose solutions must be integers. The purpose of my project is to find the solutions of a Diophantine Equation and its improvement. The first method of research for equations in the form: ax+by=c was the standard graphing method. After plotting the line, it was possible to find integral solutions. But, this method was not always accurate when coeficients were large. I then researched a method developed by Euclid. This is the method that involves a factor and remainder chart. I found this method to be rather lang and tedious. So after looking at these two methods, I set my goal as to overcome both the tedium and slow speed of the methods. My method involves the use of modular arithmatic, mod, and congruency. When I researched properties of congruence, I noticed one on which I could base my method upon. Thusly, I found the relationship between ax+by=c and $ax \equiv 1 \pmod{b}$. By finding a method of simplifying Diophantine Equations of an 'x' number of unknowns into an 'x-1' number of simpler equations in the form: ax + by = c, I was able to solve and Diophantine Equation. Also, in order to expand upon the solution sets of the equations in the form: ax + by = c, I found and researched a method to find an infinite number of integral solutions after you have found one solution set by using either Euclid's or Lee's method.

# CREATION OF A TWIN PRIME SIEVE

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A mathematical sieve is a step-by-step repeating process that finds a select subset of numbers from a larger, more general group. The most important sieve used today was developed by the Greek mathematician Eratosthenes in the third century B.C. The Sieve of Eratosthenes finds the subset of prime numbers and is essential for the understanding of many concepts dealing with primes, such as formulas approximating prime distribution.

The researcher has created a sieve which finds specifically twin primes, two prime numbers which have exactly one composite number between them. Very few discoveries concerning twin primes have been made, primarily because until now twin primes have only been treated as consecutive primes which come very close together and because many mathematicians believe that there are a finite number of twin primes. The researcher's sieve, however, shows that twin primes can be found without generating a complete list of prime numbers, and that there is probably an infinite number of twin primes.

To test the twin prime sieve for speed, the researcher wrote two programs in compiled FORTRAN on a Macintosh computer, one using the Sieve of Eratosthenes with a search routine to find twin primes, and one using the sieve created by the researcher. The twin prime sieve is 7.5 to 8.5 times faster than the augmented Sieve of Eratosthenes.

#Summer Math Scholarship - The Ohio State University
Alternate to Four Year Scholarship - The Ohio State University

# POLYOMINOES

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The goal of my project was to find a relationship between the size of a polyomino and the number of unique polyominoes of that size. A polyomino is a set of adjacently connected squares. For example, a domino is a polyomino with two squares. By unique I mean without counting reflections or rotations. To aid me in the project, I wrote a computer program in the C programming language that could find the number of polyominoes for certain sizes. To aid my cause further, I separated polyominoes into groups which had certain linesizes. A linesize is the number of squares in the longest straight line in a polyomino. The program provided me with pictures of polyominoes and their numbers. The insight gained from this data led me to derive several formulas for polyominoes with certain linesizes, which I could cross check with the computer. I also found a few formulas for 3-dimensional polyominoes. Polyominoes might be useful in designing buildings, electric circuitry, or other structures containing connected objects. Another use of polyominoes could be in researching the chemistry of carbon chains.

#Honorable Mention - National Aeronautics and Space Administration

#A STUDY OF ALTERNATING PARITY SEQUENCES IN THE $3x + 1$ PROBLEM

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The $3x + 1$ Problem defines a function f on the natural numbers x such that if x is even, $f(x) = x/2$; and if x is odd, $f(x) = 3x + 1$. Consider the sequence of successive iterates of f. For example, if the initial value is 14, the sequence formed is: 14, 7, 22, 11, 34, 17, 52, 26, 13, 40, 20, 10, 5, 16, 8, 4, 2, 1, 4, 2, 1, ... Proving that the tail of every iteration sequence is a 4,2,1 loop is a well-known unsolved problem.

I have developed an entirely new graphical method for analyzing this problem. The graph is applied to several different types of sequences. In particular, since no sequence of iterates can be of only one parity, the focus of the paper is alternating parity sequences. Can such a sequence be infinite? If not, is there a method for determining its length? I prove that all alternating parity sequences are finite. This new result narrows the search for a counterexample to the $3x + 1$ Conjecture. A corollary is that there are infinitely many alternating parity sequences with any fixed length. I am able to express the length of any alternating parity sequence as a composition of elementary functions of any iterate in the sequence. These results culminate in an iterate-generating algorithm that evaluates only the few critical iterates, but records the position of these iterates in the iteration sequence. The algorithm can check for any loop by saving only a small number of iterates in memory, whereas most algorithms must save nearly all iterates in memory. An encyclopedic survey of the $3x + 1$ Problem in the January, 1985 American Mathematical Monthly tells of no similar approach. Every result is entirely original. The research was conducted without assistance.

#First Award - General Motors ISEF/Mathematics
First Award - Mathematical Association of America
First Award - U.S. Navy
Summer Math Scholarship - The Ohio State University

THE DESIGN OF AN IMPROVED GEODESIC DOME

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The purpose of this investigation was to develop a geodesic dome design based on R. Buckminster Fuller's principles of tensegrity with less seam space than the design by Pete Christman, which is an improvement on Fuller's design. It was hypothesized that by using a series of irregular polygons as the bases for the polyhedrons, it is possible to improve on Christman's design, which has regular pentagons and hexagons as bases. Fuller's dome design consists of groups of equilateral triangles. This design is stronger than those conceived previously,and can be made with lighter materials. Christman's dome looks like Fuller's, but he combined the individual triangles under what he calls the "soccer ball" theory, which eliminates 47.2% of Fuller's seam space. The Welch design treats Christman's pentagonal and hexagonal structures as three unified layers, thus eliminating 83.75% of Fuller's seam space. This design also decreases the amount of excess material used for the construction of the Christman dome by 44%. It was concluded that it is possible to decrease Christman's seam space by 36.75% by constructing the dome as a three-layered series instead of using irregular-based polyhedrons as hypothesized.

#IT'S STILL NOT CARTESIAN: A NEW GRAPHING SYSTEM

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This project is a two year study of a graphing system that I have invented. In this system, ordered pairs are represented by segments instead of points. Each segment joins the x value of the ordered pair on the x-axis with the y value on the y-axis. Graphs of some equations in this system have crossing segments, define a finite area, and generate a curve. Using a summation of triangles, the area under the graph of $y=N-Px$ has been found to be $N^2/6P$, one-third of the area of the same equation graphed in the Cartesian system. The equation of the curve generated by the graph of $y=N-Px$ is $y=N-\sqrt{NPu}+Pu$. By a similar process, the area under the graph of has been found to be $3/8ab\pi$, three-eighths of the area of the same equation graphed in the Cartesian system. When these graphs are rotated about the y-axis, the volume of the Cartesian graph for linear equations and is three-tenths of the volume of the Cartesian graph for a circle. Preliminary research into the angles formed by segments and the areas of the graph of $y=N-Px$ was also performed. The project also covers the methods, similar to those used in integral calculus, that are used to arrive at these areas and volumes.

#First Award - U.S. Army
Third Award - General Motors ISEF/Mathematics

CREATING PERFECT FIGURES WITH SOAP

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The purpose of my project was to find out if soap films have a tendency to minimize their surface area, regardless of shape. To test this question, I set up four experiments. The first involved blowing bubbles onto a surface and studying them when they connected. I found out that they formed a film between them at equal angles. The second experiment included a ring supporting a soap film and a loop of thread. When the film within the thread was punctured, it formed a circle -- the largest figure possible. The third experiment contained two sheets of glass with thumbtacks between them. When the sandwich was submerged in the soap solution and withdrawn, the thumbtacks were connected with the smallest amount of soap solution. The fourth experiment involved geometric figures which held soap films using the smallest amount of material to interconnect the wires.

According to these four experiments and their results, soap films tend to minimize their surface area, regardless of shape. These results mean that soap bubbles can be used by mathmaticians, biologists, and other experts to help them solve their problems. Architects can design structures patterned after bubble shapes. Biologists can use soap models for cell membranes. Soap films can also be used to find the shortest length between a number of fixed points. As you can see, soap bubbles contain more than meets the eye.

MEDICINE AND HEALTH

ADOPTIVE TRANSFER OF ANTITUMOR ACTIVITY INDUCED BIOLOGICAL RESPONSE MODIFIER.

Zobeida E. Bonilla.
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The purpose of this study is to transfer adoptively antitumor activity induced by a polyantigenic immunomodulator (PAI) in donor mice to allogenic mice that have been implanted with Ehrlich's Ascites Tumor (EAT). Donor mice were immunized with 0.1 ml. of PAI on the first day. Then on the fifth day the dose was repeated and two hours after the mice were necropsied and the spleen removed. The spleens were either homogenized or their lymphocytes separated using Ficoll-Hypaque technique. Recipient mice which had been implanted with 10^5 tumor cells/mouse were injected IP either with 10^6 allogenic sensitized lymphocytes or with 0.1 ml of homogenate/mouse either daily or every three days for a period of 15 days. Lymphocytes from both immunized and non-immunized donor mice were able to reduce tumor growth (50-75%) and increase percent of survival (10-40%) in the recipient mice, however this antitumor effect was more significant and prolonged in the mice treated with the immuned lymphocytes. Homogenated preparations did not significantly influence the survival parameters. These results demonstrate that adoptive immunity with allogenic lymphocytes from mice immunized with PAI is an effective antitumor therapy. Experiments with syngeneic mice are in progress

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SECOND WIND, PULSE AND INHALATION RATES IN FIT AND UNFIT CHILDREN

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The main aim of this project was to investigate possible connections between second wind and pulse and inhalation rates in fit and unfit children. Forty healthy children were used as subjects. Each child filled out a questionnaire which enabled the child to be placed on a fitness scale of 0 to 5, i.e., unfit to fit. Each child undertook several periods of exercise. These were 1 minute, 2 minutes, 3 minutes, 4 minutes, and 5 minutes of starjumps. After each period of exercise, the children had 10 readings of their pulse and inhalation rates taken, each of 30-second duration. During a period of exercise, should a child feel an easing of dyspnea, that is, second wind, he/she commented on the sensation. The fit subjects experienced the second wind while the unfit subjects did not. Invariably, the second wind was marked by a drop in pulse and inhalation rates, thus making these entities physiological correlates to the second wind. It was possible that weight rather than aspects of fitness was responsible for some of the patterns observed. It was discovered that weight has little effect on pulse and inhalation rates of fit children, and any pattern found in unfit children is most likely due to small sample size.

ENDOTHELIAL CELL MIGRATION INDUCED BY TUMOR ANGIOGENIC FACTORS

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The object of this study is to collect, test, concentrate and isolate the Tumor Angiogenic Factor (TAF) that the C1300 tumor cell sucretes. The TAF was collected and tested for its chemotactic ability in vitro.

In this study, the chemotaxis assay had to be created through reading literature and by testing through trial and error. Eleven experiments were conducted before the assay was completed, and accurately tested the chemotactic ability of the TAF. The assays that were conducted differed from the number of endothelial cells in each chamber to the staining procedure for the membranes. The final chemotactic assay consisted of using Boyden Chemotaxis Chambers and Nucleopore Filters. These chambers consisted of two separate wells. In the bottom well the chemotactic agent was placed. Between the two wells a filter with 5 um pores was placed and then the top part of the chamber was replaced. When the top part is in place the second well is formed and the endothelial cells are placed. The chambers are then incubated and after six hours the membranes are removed and the cells from the top of the membranes are wiped off leaving only the migrated cells on the membrane. The membranes are then stained and observed.

The TAF was collected from the C1300 tumor cells, and it caused the endothelial cells to migrate. The migration occurred in as little as three hours, however the peak migration is reached at six hours. The TAF is now in the process of being concentrated.

THE EFFECT OF X-RAYS ON THE GROWTH OF FIVE COMMON PATHOGENS BACTERIAS TO HUMAN BEING AND RESISTANCE TO ANTIBIOTICS

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Calle Merced D-21, Colinas del Marquez, Vega Baja, P.R. 00763

Radiations as X-rays can cause significant changes in bacteria. If X-rays are applied to a select group of bacterias, these will be affected in their growth patterns and their resistance to antibiotics. Antibiograms were made for E. coli, Proteus vulgaris, Pseudomona aeruginosa, Staphylococcus aureus and Streptococcus agalactea. The bacteria were obtained from urine samples. In the first part of this study, the enrichment broth was divided in two aliquots that were radiated with S-rays at two different times, 1/60 and 1/30 sec., with a potence of 50KV and 50ma. Colonies count were carried out on control group and on the last two radiated broth samples. Antibiograms for the last broth samples were made.

The above procedure was repeated in the second part of the study control. The time spans were increased (4/20, 8/20 sec.), and the potence 50KV and 100MA in the last one. In the third part of the study, the procedure was repeated again with samples from the first radiated group with the same two times used before and the same potence. It was demonstrated that bacterias that were sensitive to certain antibiotics prior to exposure to the X-rays radiation became resistent to them with the exception of five antibiotics. At bigger doses of radiation the bacteria E. coli decreased their growth and the others, P. aeruginosa, P. vulgaris and S. agalactea, increased.

Aloe Vera in a Human Pseudosystem

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Due to my keen interest in research dealing with diabetes, I have created a three year study involving the use of aloe vera extract as an economical, natural, alternative method for treatment of diabetes.

An in vitro pseudosystem synthesized as an in vivo system was created to determine all factors which would contributs to the maximum effectiveness of aloe vera in that particular system, so that the glucose in solution could be decreased to an acceptable level.

Factors such as concentration of aloe vera, dosage of aloe vera, based upon predetermined volumes of solution, storage temperature, administration temperature, and PH level of the medium in which the aloe vera was added, were all considered when creating the detailed system.

Based upon the results found in each of the simplified factorial tests, the group of components responsible for this dramatic decrease in glucose levels, must be the enzymes found within the complexes of the plants succulent contents. Results plotted on a theoretical enzymatic curve approximated the ideals with accuracy.

For diabetics to ingest aloe vera orally, it must be stored at room temperature, administered at 100% pure concentrations in an approximate dosage of 0.032 x mass of individual (kg) daily.

#PROTECTION OF ACETYLCHOLINESTERASE AGAINST ORGANOPHOSPHATES BY HUMAN SERUM

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Organophosphates (OP) chemicals are insecticides and nerve gasses which inhibit the neurotransmitter acetylcholinesterase (AChE). OP also react with proteins such as those found in blood. Reaction with the noncritical proteins could reduce the amount of OP available to inhibit the brain AChE. This study was designed to determine the existence and efficacy of a passive protective system in serum against four experimental OP.

The first phase of this study confirmed the existence of protective proteins in human serum. In the second phase, human serum was fractionated in an attempt to determine the serum components active in protection. It became evident that more than one serum protein was providing protection. In the third phase, protective systems in other mammal serum were also studied. Also the reaction of the OP with purified protein samples was measured. It was found that serum albumin and pseudocholinesterase are both involved in the protective process, but that the OP did not necessarily react with the two proteins interchangeably. There is evidence that some OP bind to albumin as well as chemically react with it.

#Second Award - General Motors ISEF/Medicine and Health

#THE EFFECT OF CHANGES IN NUTRITION ON COMPENSATORY RENAL GROWTH

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Compensatory kidney growth occurs when renal tissue is lost. Several factors, including nutrition, may hinder or enhance growth. In 1985, I showed that the magnitude of compensatory growth following unilateral nephrectomy in rats varies directly with the percent protein in the diet. Of equal importance, a decrease in caloric intake, despite adequate dietary protein, severely compromised growth.

In 1986, I did this research to compare the effects of varying percentages of high and low quality dietary protein on compensatory renal growth in rats. This table summarizes the dietary treatment groups and results.

GROUP	# OF RATS	DIETARY PROTEIN qual.	%	grams	CALORIES	COMP. RENAL GROWTH R/L kid.	R kid.
1	22	high	8.5	13.4	655	13.7%	0.76gm
4	23	low	8.5	12.8	626	4.5%	0.68gm
2	19	high	19.0	28.2	620	25.6%	0.84gm
5	23	low	19.0	27.2	596	10.6%	0.71gm
3	20	high	40.0	53.0	553	45.8%	0.96gm
6	21	low	40.0	56.4	588	22.6%	0.79gm

There are two major conclusions from this study. First, as the percent dietary protein is increased, there is a corresponding increase in the percent compensatory renal growth in both the high and low quality protein groups. Second, a comparison between each member of a matched percent protein pair shows a significantly greater degree compensatory growth in the high quality protein member.

#First Award - American Medical Association
Third Award - General Motors ISEF/Medicine and Health

RADIATION EFFECTS ON NORMAL FLORA OF THE THROAT

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This research project deals with radiation and its effect on the normal flora in the throat of a cancer patient. It has been observed that after a certain amount of radiation, some patients develop infections in their throats. I believe the infections occur because some normal bacteria are killed by the radiation, and because abnormal bacteria appears in the throat. This study was to determine whether or not radiation does kill the normal flora and also to determine if abnormal bacteria appears. The project was divided into three parts. Experiment 1 and 2 dealt with radiating bacteria in a controlled environment. The purpose was to see whether or not the bacteria is killed by radiation in a controlled environment. Experiment 3 consisted of taking cultures of cancer patients throats. This was done to see whether or not the normal flora in the throat was killed by radiation. I have concluded that normal flora of the throat is not killed by radiation in a controlled environment. There is no conclusive evidence that abnormal flora always appears in the throats of cancer patients receiving radiation therapy. However, my results show, in most patients, that as the amount of radiation increases, the amount of abnormal flora increases.

HYPOALPHALIPOPROTEINEMIA AND PREMATURE CORONARY ARTERY DISEASE

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Hypoalphalipoproteinemia, a familial human disorder characterized by reduced levels of high density lipoprotein (HDL) cholesterol and apolipoprotein A-I (apoA-I), has been linked to premature coronary artery disease. In order to gain insights into the molecular defect of this disease, apoA-I, isolated from a hypoalphalipoproteinemic patient (apoA-I_{α}), was studied chemically and kinetically. ApoA-I_{α} was found to be structurally identical to normal apoA-I (apoA-I_{N}) in apparent molecular weight on SDS polyacrylamide gel electrophoresis, isoelectric point, and amino acid composition, and also to be metabolized at a similar rate as apoA-I_{N} in the normal subjects. However, both apoA-I_{α} and apoA-I_{N} were catabolized at faster rates in the hypoalphalipoproteinemic patient that in the normals. These results suggest that apoA-I_{α} is structurally normal, and the reduced levels of HDL cholesterol and apoA-I in the hypoalphalipoproteinemic patient are due to an increased rate of catabolism.

#First Award - American Medical Association
Second Award - Federal Aviation Administration

EFFECTS OF DHEA AND NORETHYNODREL ON LYMPHOCYTE LEVELS IN MICE

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Dehydroepiandrosterone (DHEA) is a steroid produced by the adrenal gland and is widely distributed throughout the mammalian body. The thymus gland, which produces T-cells, atrophies with age, thus T-cell levels decrease with age. DHEA has been shown to protect cells from the development of cancer. Norethynodrel, a structurally similar analog of DHEA, is a major component found in birth control pills.

DHEA and norethynodrel were administered to a Balb/C strain of mice at a concentration of 400mg/kg through gastric intubation 3 times a week for 8 weeks. Blood samples were then taken from mice through retro-orbital puncture. Differential leukocyte counts were taken from each mouse to check for an increase in lymphocyte levels and the average lymphocyte levels were calculated. The DHEA 8 month and 2 year groups showed a comparatively high lymphocyte level with no infections detected. A chi-square analysis was performed on levels and a statistically significant difference was shown in the DHEA 8 month group. ($p<.05$) Since T-cells comprise 70% of all lymphocytes, a rise in T-cells is inferred. Final weights were taken then mice were sacrificed through cervical dislocation. Thymus glands were removed and weighed to see if either steriod reduced the rate of thymus atrophy. The percent of thymus to body weight was calculated and averages for each group were obtained. The difference between the amount of atrophy in the 8 month and 2 year groups was determined. The control and norethynodrel groups showed age-related atrophy, whereas the DHEA group showed relatively no difference in thymus size between age groups. Thus, DHEA was shown to protect the thymus from age-related atrophy, increasing the lymphocyte and consequently the T-cell levels with age.

#Honorable Mention - Federal Aviation Administration

THE EFFECT OF FIRST AND SECOND GENERATION CHEMICAL AGENTS ON SUPRAGINGIVAL DENTAL PLAQUE

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The objective of my project is to determine the efficacy of first and second generation chemical agents on supragingival dental plaque in in vitro and in vivo environments.

Procedure for Ex. 1 Inoculate duplicate BHI agar plates and place into 0.1 ml of up to 4 rinses on one plate, incubate anaerobically, record zones of inhibition.

EX. 2 Inoculate 5.0 ml of thioglycollate broth with 0.1 ml of fresh saliva, add various quantities of rinses i.e. up to 50% concentration, quantitively estimate growth with a spectrophotometer.

EX. 3 Inoculate BHI agar plates containing from 0-20% chemical agent, incubate and record the lowest concentration which inhibits growth.

Ex. 4 Give test subjects required amount of agent and have rinse twice daily for 7 days and refrain from mechanical toothcleaning practices, sample test sites and incubate.

From the experiments conducted the following conclusions can be established:

A). All of the chemical agents can reduce and inhibit supragingival plaque growth except for sodium fluoride.

B). The effective agent in stannous fluoride is the stannous (tin) ion.

C). The most effective chemical agent is chlorhexidine gluconate in all concentrations. The second most effective agent is stannous fluoride. The less effective agents are: Phenolic compound, Plax; Plant alkaloid, Viadent; Phenolic compound, Listerine; and sodium fluoride, Act in order of greater to less effectiveness.

The most effective chemical agent after 8 days of in vivo use is chlorhexidine gluconate; second most effective is stannous fluoride; the less effective are: Phenolic compound, Plax; Plant alkaloid, Viadent; phenolic compound, Listerine; and sodium fluoride, Act.

#Fourth Award - General Motors ISEF/Medicine and Health

# TRIHALOMETHANES AND WATER CHLORINATION: BALANCING HAZARD AND HEALTH

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There are over 700 identified organic compounds in our nation's water supply sources. Ironically, the organic compounds that are thought to pose the greatest threat to human health are the ones which are created as a result of current water treatment processes. Trihalomethanes (THMs) are a class of organochloride compounds formed when natural organic constituents of river or lake water, usually humic soil compounds, combine with chlorine used in the disinfection of water to control bacteria and viruses. The most common THM produced is chloroform, which among the other THM compounds causes cancer in laboratory animals.

In my study, I attempt to show that all actions taken to ensure human health and safety consist of a balancing of risks. It is a rare situation when technologies that are used to solve one problem end up without causing unexpected, and frequently equally dangerous, side effects. Many prescription medicines are in this category. Water treatment and chlorination are classical examples of such risk balancing. I show through an analysis of data from two plants in the Fairfax County Water Authority system, that the adjustment of treatment processes and chlorine concentration is accomplished well within EPA standards. Furthermore, the risk balancing or tradeoff between the probability of death from waterborne epidemics versus those from cancer-causing agents such as THMs is acceptable from the point of view of public health. Without chlorination, the risk of death from bacterial infections is 240 people per 100,000 population. With chlorination, the risk of death from cancer is .015 per 100,000. Any incremental adjustment in chlorine concentration leads to a change in mortality estimates in both the bacterial and cancer causes of death.

#First Award - American Water Works Association

A STUDY OF CICER ARIENTUM: PHARMACOLOGICAL ANALYSIS OF ANTI-DIABETIC PROPERTIES IN DIABETIZED MUS MUSCULUS AND DIABETIC PATIENTS

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Calle Bohique CC-5, Res. Bairoa, Caguas PR 00625

Diabetes mellitus is one of the medical problem affecting society today. Some patents were interviewed and said that they controlled their sickness with Cicer arientum infusions. Cicer arientinum is a grain utilized in our daily living and is very nutrive.

The purpose of this research is to determine the effects of Cicer arientinum in diabetic patients and it's posible use as a substitute of basic treatments (insulin, ect.). The pharmacological activity levels presents in different concentrations of Cicer arientinum decoction were determined using the "Brine Shrimp Bio-assays" 97% survived and 3% died.

Sixteen Mus musculus were used divided in Controls (regular diet) and experimentals (Cicer arientinum infusion).

Clinical glucose levels analysis were realized weekly during a four week period, finding high levels in controls and normal in experimentals.

In the second stage the four diabetized controls and the experimentals were used divided in two groups "A" and two "B", with alternated diets for two weeks, finding high glucose levels in groups "A" and normals in"B".

The histological study results revealed differences in damage of the internal tissues, between control and experimentals treated with Cicer arientinum and Streptosotocin.

In the second phase eight diabetic patients type I and II were used with their respective basic treatments divided in four groups. They were divided too in Patients I (Cicer arientinum) and II (placebo).

Clinical analysis were performed finding that the combined use of Cicer arientinum with the basic treatments incrase the grade of effectiviness of them.

A Gel Electrophoresis at 20% of Acrylamide was realized to separate the Cicer arientinum's proteins and compare with insulin.

My conclusion is that Cicer arientinum has pharmacological properties.

THE EFFECTS OF CHOLESTYRAMINE ON THE CHOLESTEROL CONCENTRATION OF EGGS

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The purpose of this experiment is to determine whether an egg containing a lower yolk concentration of cholesterol can be developed. The control and experimental chickens were fed and watered twice a day. Three milligrams of cholestyramine was added to the food of the experimental group daily. The control and experimental eggs were weighed and tested for their cholesterol concentrations once a week. The cholesterol concentrations of the egg yolks were determined using Harleco Cholesterol Reagent and Standard Set 7653. All information was recorded.

The cholesterol concentrations of the egg yolks of the experimental group were consistently lower than the controls. The results ranged from 12-23% lower. The weights of the experimental eggs were slightly less than those of the controls.

From the results of this project, it is concluded that mature white leghorn laying hens ingesting three milligrams of cholestyramine daily produce eggs with a lower concentration of cholesterol than controls.

# IDENTIFICATION OF IMMUNE CELLS THAT PRODUCE DIABETES

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The purpose of these experiments was to determine the types of cells of the immune system that might be responsible for destroying the insulin-producing beta cells in the islets of Langerhans, and thereby, producing diabetes. Rats of a BioBreeding strain were used as an experimental model for human diabetic subjects. Lymphoid (immune) cells were obtained from the spleens of diabetic and diabetes-resistant BB rats. These cells were added to normal islets for the purpose of testing the ability of diabetic lymphoid cells to destroy islet cells. The latter was detected by measuring the release of ^{51}Cr from damaged islet cells. The lectin, Conconavalin A (Con A), was used to fully activate the ability of diabetic lymphoid cells to be cytotoxic to islet cells. The immunosuppressive drug, Cyclosporine (CyA), was used to inhibit the Con A activation of immune lymphoid cells. Since CyA is known to inhibit the production of lymphoid cell factors called lymphokines, in particular interleukin-2 (IL-2), the production of IL-2 was measured.

These studies suggested that: (1) Activated lymphoid cells, particularly natural killer cells, were responsible for destroying pancreatic islet cells. (2) CyA inhibits the activation and cytotoxic action of lymphoid cells directed against islets. (3) CyA prevents diabetes by its action to inhibit IL-2 production leading to an interruption in the activation of lymphoid cells.

#First Award - General Motors ISEF/Medicine and Health

IT'S ALL IN YOUR MIND

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The purpose of my project was to better understand where memory is located in the brain and how memory works in order to achieve a more efficient way to learn and remember things.

Two mice inhaled .002 iu/day of 100 mg. strength of vasopressin. I also injected two different mice with .01 iu/day of 100 mg. strength oxytocin and left two separate new mice "sober". I ran them through the maze and timed how quickly the mice learned it. I also recorded the number of days it took for the mice to forget the maze. After the tests were completed, the mice that inhaled vasopressin and two mice that did not learn the maze were sacrificed and had their brains removed. A protein analysis was then done of the temporal lobe and the surrounding tissue to check for any unique protein structures in the mice that were given the vasopressin. The new protein structure would represent the memory of the maze.

The mice that inhaled vasopressin learned the maze up to three times faster than the mice that didn't inhale the drug. They also remembered the maze twice as long as the ones that didn't inhale the vasopressin. The mice injected with the oxytocin seemed to be more confused and had a more difficult time learning the maze than the mice that weren't injected. The mice that weren't injected with the drug also retained the maze up to fourteen times longer than the mice injected with the drug. Since vasopressin and oxytocin are protein producing and blocking drugs, the results of the experiments suggest that memory is directly related to the production of proteins in the brain. It also suggests that memory may be improved through the use of protein producing drugs.

AN EPIDEMIOLOGICAL STUDY OF STREPTOCOCCAL PHARYNGITIS AND THE PRODUCTION OF ANTIMETABIOLITES DERIVED FROM MOLD GROWTH

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Purpose: The purpose of my project is to see if different types of sugar can affect the production of antimetabolites derived from natural sources of penicillium mold growth. I will be testing these antimetabolites along with commercial antibiotics to determine which is the most effective bacteriocidal acent. I want to find out how often cases of streptococcal pharyngitis occur in 100 people who have sore throats. Procedure: During a 3-month period I took throat cultures from 100 different people. I used discs to determine the occurrence of Group A strep. and Strep.pneumoniae. I performed CAMP tests to differentiate Group B strep. I used beta-lactamase discs on randomly picked bacteria. I did biochemical tests on pure cultures and also randomly picked throat cultures. I used pot.dex. agar for starch, egg yolk agar for lipids, and skim milk agar for proteins. I made a solution of mold growth using tryptic soy broth, distilled water, and a type of sugar (either glucose, sucrose, dextrose, lactose, or fructose). For each of the 15 different types of mold growth I used I made 5 solutions, each with a different type of sugar, to see if sugar could affect the production of antimetabolites. I tested these 75 solutions using the disc-diffusion method. I also tested the pH of the solutions. I tested 12 commercial antibiotics using the Kirby-Bauer method. Conclusion: Out of the 100 people I tested 52% were negative, 29% were a form of Strep.pneumo. and 19% were a type of Group A strep. 63% of the mold growth tested produced an antimetabolite. Cookies-S and J.Peppers-D produced the strongest antimetabolite. Destrose and fructose were the top two sugars that aided in the production of an antimetabolite. Chloramphenicol and Cefoxitin were the top two antibiotics.

THE EFFECT OF EXTERNAL FACTORS ON URINE IN MAMMALS

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The purposes of this project were: (a) to detect differences in several types of mammals urine in order to help explain why different urinary tract complications occur in the various animals, and (b) to suggest external factors as causative agents. Humans commonly have kidney stones and rarely bladder stones; whereas, cats and dogs encounter the opposite. A urinalysis was conducted with Bili-Labstix on these 3 different mammals. The areas of consideration were protein, ketones, pH and specific gravity of urine. These constituents of urine are related to diet, metabolism and urinary habits of these animals. These show the greatest differences to be detected. The results of 20 males, females, cats and dogs were averaged in order to compare and look for factors to help explain the original problem. In brief, the results show that diet is the most important factor in urinary complications and differences. The pH of urine in cats and females was alkaline helping to explain the existance of more urinary tract infections. The presence of protein in urin of animals shows that animals eat more protein or somehow do not absorb as much in the body as humans do. The presence of ketones in animals is related to lipid metabolism and suggests animals have higher metabolisms than humans. When trying to explain the cause for different stone formations, the more concentrated animal urine could suggest they do not release as many components of urine into the system. If they did, the released components would be closer to the final place of urine destination, the bladder. Other conclusions were drawn and the research helped explain why mammals, even though they have the same urinary system, have different complications in the tract.

#THE ADVERSE EFFECTS OF MODERATE DOSES OF MONOSODIUM GLUTAMATE ON MATURE GERBILS

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Though monosodium glutamate (MSG) is "generally recognized as safe" by the Food and Drug Administration, it has been shown to cause headaches and occasionally to induce other significant maladies in susceptible people. This study measures the effect of moderate amounts of MSG on the motor activity and learning ability of mature gerbils.

Gerbils kept in an environment with controlled temperature and fixed hours of light and darkness were fed MSG in their water in amounts comparable to levels which might be encountered in normal human diet. Motor activity was measured on an activity wheel, and learning ability in mazes.

All gerbils were less active when under the influence of MSG and showed increasing activity when MSG was removed from the diet. Both depressed activity and increased recovery time were proportional to the amount of MSG received. Gerbils on MSG were unable to learn mazes as rapidly as gerbils not fed MSG.

These findings may prove significant to students, military personnel, or others whose jobs require high levels of concentration or alertness and who frequently eat institutional food, which commonly contains generous amounts of MSG. May people fail to perform to their full potential because of what they eat?

#Third Award - General Motors ISEF/Medicine and Health

#IN VIVO IN VITRO STUDIES OF THE ANTI-CANCER PROPERTIES OF *BRASSICA OLERACEA VAR. BOTRYTIS*: PHARMACOLOGICAL AND BIOLOGICAL ACTIVITY TESTS

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The green vegetable, *Brassica oleracea var. botrytis* commonly known as broccoli was used in the inhibition of the growth and development of Ehrlich ascites tumor cells. The research was done in different phases. The pharmacological levels present in *B. oleracea* extracts were determined using the Brine Shrimp Bioassay. The three aqueous solutions presented an important pharmacological activity. The 65% dry plant extracts has the highest pharmacological levels. This solution shows a LD50 of 0.27 mg/ml.

On the second phase, five groups of three Balb-C mice in each group were treated during ten consecutive days with 0.1cc/day of several substances to serve as controls. Mice treated with distilled water, ethanolic traces, *B. oleracea* aqueous solution and *B. oleracea* ethanolic solution did not show any secondary effect in the different assays. The weight data not demonstrate any important change. The CBC test and the histological study can be observe as normal.

On the third phase the aqueous and the ethanolic solution were used to confirm the anti-tumoral properties of *B. oleracea* . The inhibitory activity in the development of the tumor cells can be observed in direct relation to the standard weight of the specimens trated with o.1cc/day of *B. oleracea* extracts, specially when we compare this results with the obvious increase in the weight of the tumor control group. The hematological assay demonstrated an outstanding neutrophils proliferation in the groups treated with *B. oleracea* extracts. The results of the histological study revealed a difference in damage in the internal tissue between the control group and the experimental treated with *B. oleracea*.

#Second Award - General Motors ISEF/Medicine and Health

*PREPARATION STADISTICAL AND PHARMACOLOGICAL EVALUATION OF AN EMOLLIENT LOTION "O/W" USING THE M. CHARANTIA LEAVES EXTRACT AS A REDUCING AGENT OF PITYRIASIS VERSICOLOR

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This project tries to provide remedy to a fungal disease called Pityriasis versicolor caused by Malassezia furfur. To do this research, test in vitro and in vivo were made. Using the concentration disc technique it was found that the extract, at any concentration, was effective. Then, twenty persons affected with the dissease were selected and gathered in four groups equivalent to the concentrations of 100, 75,50, 25 percent of M. charantia leaves extract. Three areas of the body were treated per person with the same concentration one, two and three times a day during a month. Biochemical analysis were done with the extract, like pigmentation, pH, and aminoacid. Another techniques used were: folliar analysis, Brine shrimp test, and phytochemical analysis. After finding that the M. charantia extract reduced the disease in any concentration, an emollient lotion "o/w" was designed. It was called Cru-Thie lotion, and was tested in persons affected with the disease, reflecting similar results as those of the extract. This lotion was pharmacologically and statistically evaluated comparing it with others medicaments which are used without medical prescription to reduced the disease; such as "alcohol Bengama", "Pañofin",... Cru-Thie lotion was the most effective medicament, tested "in vitro" and "in vivo". It was concluded that the Momordica charantia leaves extract and the Cru-Thie lotion in different concentrations are effective to erradicate the growth and development of Pityriasis versicolor.

*Second Award - General Motors ISEF/Medicine and Health

VIBRIOSIS - IS THERE A CURE?

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The shrimp fishery is the most valuable of the United States fisheries. The demand for shrimp increases each year; however the supply of shrimp is decreasing. With the higher demand for shrimp and the decreasing productivity of shrimp, what will become of the shrimp fisheries and markets?

One alternative which would help increase the shrimp supoly and help reduce the trade deficit in shrimp and create a new industry is shrimp mariculture, otherwise known as shrimp farming. As with any new industry, problems arise. Although commercial shrimp mariculture has been very successful in other countries, it is just beginning to take form in the United States. As with any new industry, problems arise. Various diseases are the major problem of shrimp mariculture. One shrimp carrying a disease could destroy an entire shrimp hatchery. Because of such disasterous possibilities, antibiotics are needed to kill various diseases in order to make shrimp mariculture a prosperous industry for the future.

One common disease of shrimp is vibriosis. Vibriosis is a bacterial disease that forms a necrosis on the shrimps' outer shell. Without any treatment, the vibriosis bacteria slowly creeps its way through the shell and invades the shrimps' tissues and organs--eventually causing death. This experiment is an effort to find a cure for the deadly vibriosis disease by using the antibiotic tetracycline.

Answers for disease cures and answers for shrimp mariculture are just hiding behind the door--patiently waiting to be found by ambitious explorers.

PHYSIOLOGICAL, HISTOLOGICAL AND HEMATOLOGICAL STUDY OF RELATION AND EFFECT OF ALCOHOL AND ANESTHESIA IN A VERTEBRATE ORGANISM.

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The purpose of this investigation is to determine in a physiological, histological and hematological way, the relationship and effect of alcohol and anesthesia in a vertebrate organism, to establish that alcoholics don't need a larger dose of anesthesia.

The methods and procedures used: alcoholization period, anesthesia test, histological and hematological test:(CBC and Differential Test Count). During the alcoholization and anesthesia tests, it was observed that the organism lose weight, appetite and increase the use of liquid (rum solution).

The histological study of the kidney revealed a capillar vascular congestion in the organ. The liver showed a red blood cells extravassation and a capillar congestion.

The CBC and Differential Count in the organism treatment with alcohol and anesthesia revealed a marked polycromatophilia, anisocytes and mycrocytes. Also showed an increase in lymphocytes cells. Besides, there was a high count of Howell-Jolly Bodies and reticulocytes.

Finally, I concluded that alcohol and anesthesia affects physiologically and hematologically the vertebrates organism. The apparition of Howell-Jolly Bodies can be a consequence of an hemplitic anemia. The alcoholics don't need a larger dose of anesthesia, because the alcohol is considered an anesthetics and consequently the organism of an alcoholic is partially anesthetized.

THE ROLE OF RATE OF FLOW IN MITRAL VALVE COMPLICATIONS

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The rate of blood flow through an artificial heart valve implanted through a surgical procedure is important to keep the valve in harmony with the heart's natural valves and to reduce the chance of thrombosis and endocarditis. The faster the blood flows through an artificial valve, the cleaner the valve will be and the less chance there will be for emboli to stick to the valve and cause thrombosis or for bacteria to invade and cause endocarditis. Through research it became apparent that the bileaflet style of valve had the lowest incidence of thrombosis and endocarditis, and that these problems associated with valve implantation can be related to rate of flow.

By using a pulse duplicator to pump a fixed rate of a solution of copper II sulfate which has the same specific gravity as blood into an apparatus designed to duplicate the heart's chambers, a calculated comparison of the rate of flow of three different styles of mechanical heart valves was made. The results of the experiment indicate that the rate of flow through the St. Jude bileaflet valve (6.08 ml/s) was closest to the rate of flow through a natural heart valve as simulated by my apparatus (6.09 ml/s). This was as opposed to the rates of flow for the Starr-Edwards caged ball valve (6.02 ml/s) and the Medtronics disk valve (5.95 ml/s). These experimental results parallel research in that the St. Jude bileaflet valve would result in a rate of flow closest to the optimum rate of blood flow of a natural heart valve, therefore reducing the likelihood of thrombosis and endocarditis complications and make this type of valve the most suitable for mitral valve implantation.

AUDITORY STIMULI AND ITS EFFECT ON CARDIOVASCULAR/NEUROMUSCULAR FUNCTIONS

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Results of the first of three year's research showed that classical music lowered pulse rate and rock music raised it. Second year results indicated that classical music lowered blood pressure and pulse readings of 20 hypertensive and 20 non hypertensive people.

This year's hypothesis is: Among hypertensive subjects, listening to classical music will cause a lowering of cardiovascular readings and an increase in steadiness of voluntary muscles; music will cause a greater decrease than silence; time of day is not a factor.

Twenty-two hypertensive subjects age 38-72 were individually tested 16 minutes on six occasions, with measurements recorded every 4 minutes. 3 test groups evaluated the effect of listening to music from 4 to 12 minutes into the test, group #1 with respect to pulse and blood pressure in the morning, group #2, like 1 but in the afternoon, and group #3 with respect to arm muscle steadiness. 3 control groups were identical except no music was played. ANOVA tests, run on the results, showed at a 95% confidence level, that it was music and not silence which lowered cardiovascular readings and reduced muscle tremor. Time of day was not important.

Results suggest certain auditory stimuli have beneficial physiological effects on involuntary cardiac and voluntary muscles. Music may provide a supplement to conventional treatments for persons having hypertension or trembling of voluntary muscles.

#THE INTERFERON RESPONSE IN BURN PATIENTS

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It has been suggested that an interferonopathy may play a role in the immunosuppression observed in burn patients. This study was undertaken to obtain basic information on the frequency and types of interferon (IFN) containing cells in the peripheral blood of burn patients and blood bank donors. Peripheral blood leukocytes were separated from whole peripheral blood. Leukocytes containing IFN alpha or IFN gamma were detected with an indirect immunofluorescence assay using antibodies to the IFNs. My results indicate that >5% (range, 5-10%) of the leukocytes in the peripheral blood of 8 of 33 blood bank donors contained IFN alpha. Interestingly, >5% (range, 5-25%) of the leukocytes of all 7 burn patients contained IFN alpha. In addition, 1-5% of the leukocytes of 6 of 7 burn patients contained IFN gamma and <1% of the leukocytes of the 33 donors contained IFN gamma. These findings suggest that there are differences in the number of types of IFN containing leukocytes in the peripheral blood of blood bank donors and burn patients. Also, these findings suggest that the immunofluorescence assay technique may be used to evaluate the immune status of the burn patient. Further work is being done to determine if there is a relationship between increased levels of circulating IFN containing cells and immunosuppression in burn patients.

#Third Award - General Motors ISEF/Medicine and Health

SIDE EFFECTS OF TEGRETAL AND DEPAKENE ON WHITE-OUTBRED SWISS WEBSTER *MUS MUSCULUS*

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Epilepsy can not be cured but can be effectively treated by medications; these medications, however, may produce serious side effects in some patients. This study investigated the effects of two such drugs: Tegretal and Depakene.

Forty, white-outbred Swiss Webster mice were assigned randomly to five groups of eight: Two groups received Tegretal at two different doses; two groups received Depakene at two different doses; and the last group served as untreated controls.

Hemotological and serum chemistry values were assayed on initial and concluded blood samples, and these data were analyzed using a T-test. Gross and microscopic concluded examinations of other tissues were performed. Body weight, food and water consumption and clinical appearance were monitered over a 60 day period.

Tegretol at both dosage levels produced an increase in the mean corpuscular hemoglobin concentration (MCHC). Tegretol and Depakene at both dosage levels caused an increase in the polymorphonuclear leukocytes and a decrease in the lymphocytes. All test animals showed elevated liver enzymes. Microscopic examination of the liver confirmed damage in the test groups administered the higher dosages of both drugs.

Offspring of the test animals were checked for teratogenic effects. The offspring of the Tegretal females had moderate hemosiderosis in the spleen. The offspring of the females in both experimental groups also revealed liver damage. These findings seem to indicate that further research is needed to determine if these medications cause similar damage in humans and if the damage is severe enough to warrant restrictions on the medical usage.

[#]FURTHER STUDIES OF *ARCHAS ZAPOTA* EXTRACT ANTINEOPLASTIC ACTIVITY: A BIOMEDICAL AND BIOCHEMICAL APPROACH

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This research originated from the use of *A.zapota* in Puerto Rican folklore in the treatment of ulcers. The objective was to study the pharmacological possibilities of extract. The antineoplastic effects were compared with MTX. Tumor growing control studies showed 86% of reduction when using *A.zapota* and 99% of reduction when using MTX. No death was observed. Acute and chronic toxicological studies were performed. Data showed that *A.zapota* has a very low toxicity. Cardiovascular evaluation, open-field behavioral observation of treated specimens and Teratological assay of nine mating situations (via external examination and *post mortem* X-Ray radiography). The important results also reiterated *A.zapota* EXTRACT low toxicity, however, adverse cardiovascular effects and increased locomotive activity, and a high incidence of neonatal death was observed in MTX-treated groups. This was in accordance with previous reports of MTX high toxicity.

Biologically, many antineoplastic agents have become useful in the treatment of bacteria. The tests were: MIC, growth curve, sensibility zone and metabolism with four sugars. These tests concluded that *A.zapota* extract can be considered good antibacterial agent.

Biochemical analysis, based on the generation of density gradients of phase separated *A.zapota* samples still preliminary. Similarly a histo-pathological examination of EHS sarcoma tumoral tissues is still underway to elucidate the antineoplastic and antibacterial activity. These analyses will provide some information of the *in situ* action at the cellular level.

It is anticipated that the further studies about *A.zapota* may provide the basis of a new promising antineoplastic and antibacterial agent.

[#] Third Award - General Motors ISEF/Medicine and Health

#DETERMINING THE EFFECTIVENESS OF FARM DISINFECTANTS

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On any type of livestock ranch or farm, there are many important factors that must be taken into consideration to insure a healthy, productive herd. Using good breeding stock, feeding quality feed, and practicing good animal husbandry are all important measures that must be taken. Another important step is having a good disease control program. Vaccinating is mandatory in order to prevent most disease, but disinfecting equipment and facilities with an effective disinfectant is probably the best insurance against disease. The purpose of this project is to determine the safest, most effective disinfectant for use on livestock buildings and equipment.

To begin my project, I sent letters to professors at top universities requesting information on testing disinfectants as well as identifying different types of bacteria found on the farm. I then grew pure cultures of three different types of bacteria on tryptic soy agar plates. I used the disk-method to test ten different brands of disinfectants on these cultures. I observed the results (a clear-zone of inhibition around the disk) by measuring the clear-zones, and then photographing each petri dish individually. In the next phase of my experiment I repeated the disk method process. This time I tested the disinfectants on cultures I had obtained from our farrowing house and a dairy barn. I recorded all of my results, and a definite trend was seen showing that some of the disinfectants were very effective against bacteria while other disinfectants were not. By determining the effectiveness as well as the characteristics of each disinfectant, I have determined where each one can be used the most safely and effectively on the farm.

#Fourth Award - General Motors ISEF/Medicine and Health

ANTIBIOTICS AND PLASMID FORMATION

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One of the most fascinating characteristics possessed by organisms is adaptability. Any surviving organism must be able to change with its environment. Often such changes involve mutations at the plasmid level. For this particular investigation, E. coli were the organisms being observed. The normal number of the bacteria found in a mouse was drastically reduced with the introduction of tetracycline. The antibiotic created an environment in which the E. coli could not survive. The organism had to either adapt or die. Resistant or "R" plasmid formation would constitute such an adaptation. It was predicted that the bacteria would form the R plasmid and, therefore, produce colonies on tetracycline-containing media. After six weeks of testing, however, no R plasmids had formed. After four weeks with no resistant E. coli, two of the experimental mice were given already resistant E. coli orally. Surprisingly, even these organisms could not survive in the mice. Factors within the hosts prevented not only the formation of plasmids resistant to tetracycline, but also prevented the growth of E. coli with resistance to the antibiotic. But what are those factors? Can one conclude that the administration of antibiotics in the diet has positive aspects? These questions and others are the challenge presented, and I hope to have answered them in my investigation. The impact of this study applies to the current controversy on the use of antibiotics (including tetracycline) in the feed of livestock.

#DID YOU HEAR - WHAT'S YOUR EYE-Q? A FIVE YEAR STUDY

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"Did You Hear - What's Your Eye-Q?" is a five year science fair project studying whether computers can aid in the testing of eyesight and hearing. "Eye-Q" is my coined word which relates to the ability of seeing an item and then understanding and performing an action. Another objective of the project is to determine trends in vision and hearing as a function of age.

In 1987, the programs were entirely rewritten for the Amiga computer and a new test on hearing was added. (The programs previously were for the Commodore 64 computer.) The Amiga computer permitted the storing of all the test data in one file in memory. This permitted the Amiga to be used in the analysis of the test data. The ability of the Amiga computer to speak was used in a number of experiments and its stereo capability was used for the hearing test.

The procedure for evaluating the above hypotheses were the following eight experiments: Basic Reaction Time; Color Dot Perception; Visual Acuity; Amsler Grid Test for Macular Degeneration; Astigmatism; Persistence of Vision; Color Blindness and Hearing. The first seven of these tests were designed around the three major actions associated with eyesight which are the ability to see, the brain recognizing what is seen, and then the hand, etc. taking the necessary action on what is perceived.

The results verify the hypotheses that eyesight, perception and hearing, in general, decline with age and that computers are excellent labor-saving devices for this evaluation.

#First Award - American Optometric Association and the Auxiliary to the American Optometric Association

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5 YEAR STUDY-THE EFFECTS OF ELECTRONIC GAMES ON HUMAN PHYSIOLOGY

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1300 Bundy Blvd., Winona, MN 55987

I tested approximately 40 people each year for: Blood Pressure, Pulse; Reaction Time, Eye-Hand Coordination; Galvanic Skin Resistance, External Body Temperature; Eye Focusing; Brain Waves. Procedure: The same procedure was followed the first 4 years except for time limit changes. First the subject would rest for a given amount of time. Each of the games was played for the same amount of time. After playing the games, the subject was retested and compared for a difference, averaged, recorded, graphed, and put into a conclusion. The 5th year testing was done while playing the games. All tests were classified by the following age groups: 0-10, 11-15, 16-25, 26-35, 36-49, 50 and over. Hypothesis: That video games will have more of a negative effect on the body functions than a positive one and effect all age groups. I think that after playing these games the body will react negatively. Conclusion: Based on my research, my conclusion is that playing electronic games has a negative effect on the human body in the following areas. It caused the pulse to rise, blood pressure to go up in most cases; stress (measured by Galvanic Skin Resistance), and external body temperature increased; prolonged playing caused eye fatigue as shown by the increased need in lens power to return to best vision. The positive effects playing the games had were an improvement in Reaction Time and Eye-Hand Coordination in most cases and an increase in brain wave activity.

#Second Award - U.S. Air Force
Third Award - General Motors ISEF/Medicine and Health

ISOLATION OF THE ENZYME THAT BREAKS DOWN HYDROPEROXIDE

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The purpose of this research was to isolate and extract the enzyme that breaks down hydroperoxide in cucumbers.

Cucumbers, as well as other vegetables, are only one source of hydroperoxide. This substance, which is also found throughout the human body, greatly effects the immune system. As healthy human beings, an enzyme regulates the level of hydroperoxide in our bodies so as to maximize the ability of our immune system. As we grow older, however, less of this enzyme is present, thus the level of hydroperoxide is dangerously high. This explains the severity of even slight disease in the elderly. If this enzyme can be controlled, the possibilities are unlimited. We may be able to increase life expectancy or even help in the fight against AIDS. We also have reason to believe that this enzyme may be able to combat cancer.

Through four major experiments consisting of, in short, dialysis, incubation, extraction, spectrophotometry, high power liquid chromatography, and radiation counting, this highly unstable enzyme was successfully isolated. After collecting more of the enzyme, it will be studied and analyzed so that we may find a way to control it.

#SERUM LYSOZYME: AN INDEX OF MACROPHAGE STIMULATION

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No abstract received.

#Third Award - General Motors ISEF/Medicine and Health

THE ADHERENCE OF MAMMALIAN CELLS TO THE PROTEIN FIBRINOGEN

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During the wound healing process, cells from surrounding tissues migrate into the wound to cover the wounded area. These cells must recognize and adhere to some component in the blood clot. By coating wells with different proteins from the blood clot and adding bovine endothelia cells to each coated well one can observe the number of cells attaching to the different proteins. To identify the active structure in the adhesive protein, synthetic peptides corresponding to different regions in the adhesive proteins, were added to the wells. The ability of these peptides to inhibit cell attachment was quantitated.

This project demonstrates that cells adhere to the protein fibrin/fibrinogen in the the blood clot. The a polypeptide chain, with the amino acid sequence RGD, is the structure in the fibrinogen molecule attracting cells.

# TRANSFECTION OF HUMAN CELLS WITH ONCOGENES

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Human cancer cells are not usually used in cancer research because cells taken from human tumors do not survive in an artificial environment. Possibly, human cells which are accustomed to an artificial lifestyle can be transfected, or made cancerous. A scrape loading technique may be applied to transfect a culture of human cells.

The project consists of three steps. The first is to scrape load a fluorescent dye into a human cell culture to ensure that the technique works. The second step is to scrape load an activated cancer gene, or oncogene, into a human tissue culture. The final step is to demonstrate oncogene activity in the culture.

The dyes were successfully scrape loaded. An activated oncogene, the ras sequence, was scrape loaded into a wounded, confluent culture of human foreskin fibroblasts. The culture lived for seven days until it was fixed to the slide with acetone. The ras-oncogene was visualized as part of the genotype of the scrape loaded cells with the in-situ hybridization process. At this point, it cannot be assumed that the gene is functioning within the cells.

#Fourth Award - General Motors ISEF/Medicine and Health

CAN BILIARY GLUCARIC ACID PREVENT THE FORMATION OF PIGMENT GALLSTONES?

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The purpose of this study is to develop a method for quantitation of D-glucaric acid in the bile and to evaluate its significance in regard to its effect on β-glucuronidase activity and pigment gallstone formation. The method developed involved a 5-fold dilution of the gallbladder bile, followed by extraction of bile acid and bilirubin with tetrahexylammonium chloride, boiling of the infranatant for 40-60 min, and determination of the percent inhibition of human β-glucuronidase activity during incubation at 56°C, pH 4 for one hour. The value is then converted to the concentration of D-glucaric acid by using a standard curve. The D-glucaric acid content together with bilirubin, bile acid, and protein were determined in 106 human gallbladder biles obtained at autopsy including 20 with gallstones. The mean D-glucaric acid content is 1125 ± 159 uM (Mean ± S.E.) or 16.2 ± 2.2 uM/mM of bile acid. The biliary excretion of D-glucaric acid seems to be facilitated by the excretion of the bile acid since the D-glucaric acid content in the bile is positively correlated with the amount of bile acid but not with bilirubin or protein. Biliary β-glucuronidase activity is, however, not affected by D-glucaric acid in vivo because (1) D-glucaric acid content of the bile in subjects without gallstones is identical to that in patients with gallstones, (2) D-glucaric acid content does not correlate negatively with the β-glucuronidase activity in the bile, and (3) at the usual pH of the bile the formation of D-glucaro-1,4-lactone from D-glucaric acid is quantitatively negligible. We conclude that biliary D-glucaric acid plays no significant role in the prevention of pigment gallstone formation.

OLFACTORY DISCRIMINATION: DOES IT DETERIORATE WITH AGE

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The sense of smell is one of our most used but least understood senses. In an attempt to determine the effect of aging on the olfactory lobes, a smell identification test was given to one hundred sixty persons. The test group ranged in age from six to one hundred two years. On the average, women out scored men, developed the sense earlier, and retained it longer. It was found that age did indeed play a role in one's ability to distinguish odors. Peak performance for females occurred during the late teens and early twenties; whereas, the peak performance for men did not occur until the mid thirties. There was a dramatic decline in the ability to distinguish smells after the age of sixty-five and on the average was almost nonexistent after the age of eighty. It was also found that smoking plays a large role in the ability of one to identify smells.

EFFECTS OF PHYSICAL CONDITIONING ON INSULIN ABSORPTION IN _RATTUS NORVEGICUS_

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No abstract received.

THE TOXICOLOGICAL EFFECTS OF DIMETHYL SULFOXIDE

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The purpose of this research was to find the long term effects resulting from use of non-medical grades of DMSO, dimethyl sulfoxide. This paper takes three years of research and observations to show the effects of non-medical grades of DMSO. The major concern was with the non-medical grades of DMSO because of the growing use of the impure grades to treat minor aches and pains in humans. The drug has been observed to have a noticeable effect on the pregnancies of mice, to cause an abcess to form on and around the liver and heart and to cause deposits of salt-like material in the bladder. Also noticed were tumors in the lungs.

At present there is insufficient evidence to show that this drug is either safe or effective in treating any medical condition.

#Fourth Award - General Motors ISEF/Medicine and Health

TITLE: DOES THE INCREASE IN BLOOD GLUCOSE CAUSE ANALGESIA?

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For as long as I can remember researchers and scientists have studied and concluded that glucose makes humans excited. Recently researchers and scientists concluded that glucose causes activity in the initial minutes of digestion. After the glucose has been fully digested, the body becomes very relaxed to an almost sleep-like state. Thus, this semi-conscious state raises the body's pain tolerance.

It has been known that diabetics have a higher pain threshold than non-diabetics because of their high glucose levels. Pain, though unwanted is a necessity to signify or alert the body of problems. Because of the many complications of diabetes, some of which end up in amputation of the limbs, it is necessary to see what actions, if any, increase in blood glucose levels have on analgesia.

The information received from the results of this experiment may be beneficial in not only understanding of the physiological role glucose may play, but also open avenues to treating diabetes and reducing the unwanted debilitations caused by diabetes.

SURVIVAL OF INTRATESTICULAR RAT ISLET ALLOGRAFTS

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In 1957 Snell suggested that passenger leucocytes carried along with transplanted organs might be responsible for the initiation of allograft rejection. It has been demonstrated by Lacy et.al. that the culture of islets at 24°C destroys these passenger leucocytes. This factor, along with the fact that the Leydig cells of the testes produce testosterone and other steroids, which promote a local immunosuppressive effect, should therefore prolong allograft survival. The control series consisted of transplanting freshly isolated islets to the streptosotocin-induced diabetic recipients. The experimental series entailed the culture of islets for seven days at 24°C, and then transplanting the islets to the recipients across the same strain of rats, Wistar-Furth to Lewis. Orchidectomies were performed on those experimental recipients which survived past 60 days, which resulted in a return to the diabetic state. Days survival of the control series (Mean±SEM) was $9.14 \pm .74$, whereas the experimental series was $> 44.86 \pm 8.58$. It is therefore evident that the low temperature culture and the choosing of the testes as a transplant site are responsible for prolonging graft survival.

#First Award - American Medical Association
Second Award - General Motors ISEF/Medicine and Health

# CHEMOTHERAPEUTIC TREATMENT OF CANCER IN VITRO AND IN VIVO PHASE II: BHA AND GOSSYPOL STUDIES ON CEM HUMAN LEUKEMIA AND LEWIS LUNG CARCINOMA

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The purpose of Phase II of this study was to determine the effects of butylated hydroxyanisole (BHA) and gossypol on CEM human leukemia cell line in vitro and on Lewis lung carcinoma in vivo. CEM cells were maintained in RPMI media. The following dilutions of drugs in DMSO were made to determine the IC_{50}: 50μM, 10μM, 1μM, 0.2μM, and 0μM. Cells were sampled at 0, 24, 48, and 72 hours and cell counts were done. Thirty-five C57/BL6 female mice were divided into seven groups. One group received tumor cells and the vehicle. Two groups received tumor cells and 25 mg/kg or 5 mg/kg dosages of gossypol. Two groups received tumor cells and the same dosages of BHA. The final two groups were treated with 25 mg/kg of each drug. The parameter was median survival time.

All concentrations of DMSO below .5% do not have an adverse effect on growth of CEM cells. 0.2μM, 1μM, and 10μM doses of gossypol inhibited the CEM growth for 48 hours, but then lost its effectiveness. The 10μM concentration of BHA reduced the cell count 90% from initial counts. 1μM is also effective. After 21 days of in vivo testing, 100% of the control group and all BHA experimental groups survived. Only 20% survival was seen in the 5 mg/kg gossypol test group; 40% survived in both groups receiving 25 mg/kg.

All doses of gossypol appear to be inhibitory only during initial treatment of CEM human leukemia in vitro. The 10μM BHA appears to be the optimal concentration for treatment of CEM cells in vitro; 1μM is also very effective. Data suggest that gossypol does inhibit Lewis lung carcinoma in the C57/BL6 strain of mice. However, toxic side effects may occur and further studies should be done. BHA appears to be very effective in controlling Lewis lung carcinoma in C57/BL6 mice. Further tests on higher species should be pursued.

#First Award - U.S. Army
Second Award - Patent and Trademark Office/ U.S. Department of Commerce/
Patent and Trademark Office Society
Fourth Award - General Motors ISEF/Medicine and Health

IMMUNOGLOBULIN RESPONSE OF GINSENG-FED MICE

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The great threat of AIDS occurring sparked my interest in invigorating the immune system. Since ginseng is said to lengthen life and since immunity decreases in old age, I hypothesized that ginseng affects longetivity by revitalizing the immune system. The researcher separated eighteen mice into three groups of six. Group one was the control group, group two was fed ginseng 5 mg/100 g body weight, and group three was fed 10 mg/100 g body weight. The dosage was given on a piece of bread, while the control recieved a placebo of bread. During the first week, ginseng was not given but the blood was extracted and tested. However, the remaining weeks ginseng was given. Fortnightly blood was taken from each mouse through the retro-orbital vein. The blood serum was obtained and pooled in groups of two from their respective groups. Then the sera's immunoglobalins were counted by the enzyme-linked immunospecific assay (ELISA). There was no notable weight change due to ginseng. The researcher did note, however, that the testicle size of the experimental mice increased. Though the levels varied from week to week in all the groups; after ginseng was given, the experimental mice had higher immunoglobalin levels. Therefore the researcher concluded that ginseng affects the immune system.

S.I.D.S. A TWO YEAR PHYSICAL AND PSYCHOLOGICAL STUDY

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The problem I was trying to solve was what were the basic causes of infant death and what they have in common. I also wanted to find the emotional aspects of infant deaths.

I went to various hospitals, county agencies, and libraries to collect information. I also went to the county coroner to look at the death records and collect information from our area to create statistics. On my physical study I found that S.I.D.S. is the sudden unexpected death of an apparently healthy infant. I also found the greatest risk victims. The thought causes are dopamine excess, apnea, sleeping in a separate room from the parents. Speech and S.I.D.S. are also tied together. I also found out about monitoring an infant.

My psychological study included going through the steps of parents and children. The stages were shock, denial, anger, and grief.

From my data found that S.I.D.S. is more common in males than in females by eighteen percent. Death times A.M. vs. P.M. these times were more equal than they should have been differing by only four percent. The most common type of birth premature vs. fullterm, fullterm was greater by six percent whereas research shows that premature births should be more common. Autopsies were only done fifty-five percent of the time, this also should have been higher. The greatest risk age for S.I.D.S. was six months followed by one year and one month. I found that there were twenty-one different diagnoses in our area. S.I.D.S. was listed in twenty-four percent of the cases.

# STREPTOCOCCAL PHARYNGITIS: EPIDEMIOLOGY AND IMMUNOLOGY PHASE III

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The results of research in Phase I indicate effective acquired immunity against streptococcal pharyngitis, contrary to current texts. If there are a limited number of the 70-M types causing strep throat in a semi-isolated population, type specific immunity could be effective. Phase II and III are concerned with finding a method to determine the number of unique organisms causing strep throat in the population. Phase III also investigates differences in growth patterns of the cultures isolated in the presence of both sera and antibodies. Phase III: protein M-types are determined by Dr. Edward L. Kaplan, University of Minnesota. **Procedure:** 1. Five organisms obtained in 1986 were taken through Blood Passage Procedure to assure M protein production. 2. Throat swabs were taken from clinically ill patients of Dr. Brent Jackson to isolate current cultures. 3. 225 sera plus controls were taken through Opsonization Procedure to determine presence of type specific anti-M opsonizing antibodies. 4. Organisms were grown in media containing Todd-Hewitt broth, normal rabbit serum, and two human sera to observe any difference in growth patterns, particularly chaining. 5. Antistreptolysin O titers were determined by Difco method. 6. Group A cultures were sent to Dr. Ed Kaplan, U. Minnesota for typing. **Results; Conclusions:** 1. ASTO titers are significantly above the expected normal range. 2. Of the 25 sera tested, 50% contain opsonic antibodies to organism #5. 3. Of the same 25 sera tested, 44% contain opsonic antibodies to organism #3. 4. 1985 was an epidemic year for group A beta strep in East Millard. There were 31 positive cultures obtained. In 1986, five were positive. In 1987, there were no positive cases of strep among the patients seen by Dr. Jackson during the same time frame. 5. Five organisms isolated are distinct M types according to my research in 1987.

#Honorable Mention - Eastman Kodak Company

#TUMOR CELL MATURATION ASSAYED BY CHANGES IN CELL SURFACE PROTEINS

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Most leukemias result from the unregulated growth of immature blood cells. T-cell leukemias are caused by immature T-cells that are not able to perform their normal function. Most T-lymphoma cells lack two cell surface proteins which are present on normal mature T-cells (called Lyt2 and L3T4 in mouse, T8 and T4 in human). These proteins are important for the normal function of both human and murine T-cells. The SL12.4 murine T-lymphoma cell line, used in these studies lacks Lyt2 and L3T4 cell surface protein. The hypothesis is that the expression of Lyt2 and L3T4 genes are inhibited by a protein repressor. This study was initiated to examine whether inhibiting protein synthesis by cycloheximide (CHX) allows Lyt2 and L3T4 protein expression to occur. If Lyt2 and L3T4 genes were expressed during CHX treatment, then the mRNA for those genes will accumulate in the cytoplasm, and translated into Lyt2 and L3T4 protein once the CHX is removed. SL12.4 cells were incubated with CHX, followed by removal of CHX by washing the cells several times and replating for different times to permit the cells to resume protein synthesis (CHX is a reversible inhibitor of protein synthesis). The cells were assayed for the appearance of cell surface Lyt2, L3T4, and the expression of ThB protein which is constantly expressed by the cells. Specific antibodies bound to fluorescent dyes which recognize and bind to these proteins were used to detect the presence of these proteins by a fluorescence activated cell sorter. The results of this study showed that there was an increased level of Lyt2 and L3T4 surface expression after a pulse with CHX. The response was specific since ThB protein expression was not increased. It is concluded that Lyt2 and L3T4 expression may be regulated by repressor proteins and thus the maturation of T-cells may involve the selective inactivation of repressor proteins.

#Second Award - General Motors ISEF/Medicine and Health
Second Award - Tissue Culture Association

#DIABETIC BLOOD GLUCOSE MONITORING SYSTEMS-EVALUATION,EDUCATION AND INNOVATION

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Diabetes is a condition that occurs when there is too much sugar in the blood, It affects over 65 million people worldwide, in all age groups and social areas, and is caused by the failure of the pancreas to produce insulin. If insufficient or no insulin is produced, then the level of glucose keeps rising, ultimately causing death,

Many diabetics must inject artificially prepared insulin daily. To establish the correct dosage, the patient must carry out a blood glucose analysis test. These recently introduced test kits work on the principle that glucose present in blood is catalysed by the enzyme Glucose oxidase to produce gluconic acid and hydrogen peroxide. The peroxide then oxidises a dye to produce a visually read colour change.

In less than a year, these blood testing kits will be freely available on the National Health Service, for use by all Britain's diabetics. Consequently, I undertook an independent study into the accuracies of the available test systems, with respect to light, temperature, humidity and chemical contamination. I have also carried out a survey into the user-friendliness of the systems and am presently developing a new test system, that will hopefully make life more bearable for the world's diabetics.

#Honorable Mention - Federal Aviation Administration

LOCAL SCAR TISSUE PREVENTION

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This project determined the effects of Mineral Oil, Liquid Silicone, and Silicone Gel in preventing post-operative scar formation around the sciatic nerve. Twenty male rats ± 6 weeks were divided into 4 equal groups. In surgery (with Halothane and .25 cc injectable Ketamine for anesthesia), the sciatic nerve was exposed, surrounding tissue irritated, and a substance used topically to insulate the nerve. Each substance was applied on an individual basis to each rat in its respective Group; no substance was applied to the Control. After wounds were allowed to heal for 14 days, 1 rat from each Group was sacrificed (by inhalation of Halothane) at 2,3,4,5, and 6 week intervals. The sciatic nerve and surrounding tissue were removed and placed in 10% Formalin. Tissue specimens were made into slides, photographed, and compared to analyze the development of scar tissue. Scar tissue formation was present in all 4 groups. Compared to scar tissue around the nerve in the Control Group, Mineral Oil and Liquid Silicone formed scar tissue around droplets which were dispersed into the muscles. Silicone Gel provided a solid barrier which was not penetrated by scar tissue. The surgery and substance application were well tolerated in all groups. Neither Mineral Oil nor Liquid Silicone were successful in preventing post-operative scar formation around the sciatic nerve. Although Silicone Gel helped to insulate the nerve from scar tissue, its ability to mimic the body's natural tissue was limited. Wound healing was delayed with Mineral Oil and Liquid Silicone because the nerve was bound to surrounding tissues; this process was only altered with Silicone Gel because a cavity was formed around the nerve. The results of this study using 3 inert substances to prevent abnormal scar tissue formation around nerves, is only the first phase in a search for a biocompatable material.

#Honorable Mention - Eastman Kodak Company

#RADIATION: HOW MUCH IS TOO MUCH PHASE V: THE EFFECTS OF COBALT 60 ON WHOLE BLOOD CELL CULTURES FROM THE HOMO SAPIENS MAINLY DEALING WITH CHROMOSOMFAL INTEGRITY

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Hypothesis: Radiation will cause chromosomal damage in human whole blood cell cultures. Procedure: Obtain canine marrow and human whole blood. Irradiate with Co-60 at 0, 50, 100, 200, 400 rads. Culture. Harvest. Make slides and stain slides. View 100 metaphases per dose. Data: This experiment was done six times before a successful conclusion was reached. The marrow cultures did not have enough cells growing to collect significent data. But in the whole blood cultures, a variety of breaks were noted. At 50 rads 7% of the cells had a gap in a chromosome. 14% of the 100 rad group had either fragments or gaps. Fragments, gaps, and dicentric chromosomes were noticed in 29% of the 200 rad set. The 400 rad group had dicentric/tricentric chromosomes, rings, gaps, fragments, and multiple breaks in all the cells viewed. Endoreduplication was viewed in the 100, 200, and 400 rad groups. Conclusion: Radiation causes damage to the chromosomes of the Homo sapiens in whole blood cell cultures which results in leukopenia. In doses as little as 50 rads, gaps are seen. As doses increase more damage can be seen.

#First Award - U.S. Air Force

Hyperglycemic Research: A Possible New Enzymatic Method for Early Detection of Juvenile Diabetes. Phase II

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Up to the present time, there is no known early warning detection system for Diabetes Mellitus; juvenile onset. Therefore,the goal of this author's research was to find out the correlation, if there is any between early Amylase levels and late glucose levels before and after Insulin introduction, in the Bio-breeding/Worchester Rat.

54% of the BB/W diabetic prone individuals, became diabetic, based on measures of blood glucose, urine glucose, and ketone levels, between age 79 and 86 days. High positive correlations were achieved as early as between Amylase at age 30 and glucose on age 60 for all diabetic individuals, a mean of 22 days before the confirmation of diabetes. After Insulin introduction, the high correlations previously encountered were not acheived.

Due to the correlations between early Amylase and the onset of diabetes, the results suggest that the Amylase levels in humans should be checked during routine lab blood analysis, especially in patients with a history of diabetes in the family. A data bank would be established and correlations determined.

Early warning detection would allow immune prevention therapy to be undertaken before the onset of glycosuria, and perhaps prevent the process of diabetes before it begins.

#First Award - American Medical Association

#THE EFFECTS OF THE DRUG ESTRAMUSTINE ON BULL SPERM AND SUBSEQUENT INTRACELLULAR TARGETS OF ESTRAMUSTINE

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The purpose of this project is to determine the potential effects of estramustine (EM), a drug used to treat prostate cancer, on bull sperm motility. Experiments done with intact, detergent-lysed, and lysed and trypsinized bull sperm indicate that 120uM EM binds intact and lysed sperm, but not lysed and trypsinized sperm. Experiments done with lysed and reactivated motile bull sperm indicate that 120uM EM completely inhibits sperm motility.

These results indicate that EM binds two components on bull sperm: a component on the surface membrane (as indicated by the stained intact sperm), and a component on the 9+2 microtubule doublets (as indicated by the stained lysed sperm), which are responsible for sperm motility. These results also indicate that the component on the 9+2 microtubule doublets which EM binds is the protein dynein. This protein is removed from the doublets in the lysed and trypsinized sperm, and these sperm are not stained by EM, indicating that EM binds the dynein component of the doublets. Since dynein is the chief motility protein and would have to be bound by EM for inhibition of motility to occur, this interpretation is further supported by the inhibition of lysed sperm by EM.

In future experiments, I am planning to examine the effects of EM on the dynein ATP-ase by isolating this ATP-ase. By comparing the effects of EM on this ATP-ase to the effects of EM on similar ATP-ase's in the prostate, it might be possible to finally understand the unique mechanism of action of the drug estramustine.

#Third Award - General Motors ISEF/ Medicine and Health

THE VON WILLEBRAND DISEASE, GEOGRAPHIC DISTRIBUTION AND FAMILY RELATION

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After various diagnosed cases with Von Willebrand Disease, other family members were interviewed and the family tree was completed four generations back. From this information eighty four (84) persons who presently live in Puerto Rico were identified with characteristic signs of the condition. Seventeen (17) actually live in the United States. This number exceeds the estimated provided by the Hemophilia Foundation of Puerto Rico. Most of the cases are found in Aibonito and associated with the surname Alicea. Since twenty four (24) additional cases are scattered in fourteen towns, a possible relation to the Alicea family should be considered. In each case the genetic mechanism present in these families need to be determine. Significant increase in future generations must be expected. Genetic counseling should also be provided to all family members.

STUDIES OF THE ANTICANCER ACTIVITY OF MISTLETOE AND ITS CONSTITUENTS

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Aqueous extracts of mistletoe plant (Viscum album) are widely used in European countries for the treatment of cancer. We have extracted alkaloids from these plants. These alkaloids have been partially purified and assayed for anticancer activity in an accepted experimental system. It is proposed that the anticancer activity of mistletoe plant may be due to its alkaloids and further purification and biological studies may provide a new anticancer drug.

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*BIOLOGICAL MODIFIERS FOR NATURAL KILLER CELLS: NEW APPROACH TO CANCER

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This science fair project tests a new approach to curing cancer. It assays herbal preparations to see if they act as exogenous biological response modifiers for natural killer (NK) cells. More specifically, it assays these herbs to see if they increase the activity of natural killer cells. It also studies whether or not these herbs, when added with gamma interferon, produce a synergistic effect on NK activity. NK activity was measured by using a standard assay. The results of the study showed that two of the herbs increased NK activity and that one of them produced a synergistic effect. Since NK cells are believed to play an important role in the prevention or occurrence of cancer, these herbal preparations, by acting as exogenous biological response modifiers, may suggest a new approach to cancer therapy.

*Third Award - General Motors ISEF/Medicine and Health
Honorable Mention - American Intellectual Property Law Association

* BIOCHEMICAL DETERMINATION OF BONE DENSITY

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Osteoporosis, a harsh disease where bone is lost faster than it can be replaced, affects over 20 million Americans and is the leading cause of death among older women. The only method for detecting osteoporosis, densitometry, is relatively exact but not widely available nor can it predict disease. In an attempt to find a biochemical predictor of osteoporosis, this project compares bone density urinary carboxyglutamic acid (Gla) and urine calcium loss after an 11 hour fast in 19 women subjects. Gla, an amino acid in bone formation, and calcium are expected to increase in the urine as bone loss occurs. These factors should correlate to bone density. The subjects age 25-45 had their os calcis bone density measured, filled out a diet/exercise/medical history record, and collected two urine samples after an 11 hour fast on two nights. Samples were assayed by atomic absorption spectrophotometry for calcium, colorimetry for creatinine, and high pressure liquid chromatography for Gla. Chemistry results were expressed as creatinine ratios. Subjects were divided into groups by age, estrogen use, exercise and intake. Results were graphed and analyzed by Spearman-rank correlation coefficients, analysis of variance, and linear regression. The linear regression for Gla vs. bone was displayed for all normal bone density subjects. Certain markedly different points made the confidence limits very high. The linear regression for calcium vs. bone density was significant in subjects with no supplemental calcium. The subjects studied were normal and their Gla values fit the regression lines. My future work will be to determine if values from osteoporotic subjects fit these lines. These results are the first of their kind which allow the prediction of bone density from urine Gla values.

*First Award - National Aeronautics and Space Administration
First Award - U.S. Navy
Second Award - Sigma Xi, The Scientific Research Society

INVESTIGATION OF FLUORIDE USE IN THE ARDMORE PUBLIC WATER SUPPLY

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In this project I have investigated why and how fluoride is added to the Ardmore, Oklahoma public water supply. I began with a review of the literature on the history of fluoridation. I asked about why fluoridation was needed, the benefits to be gained and some of the drawbacks of too much fluoride. When I interviewed the water department official I discovered how fluoride is added to the water and how it is monitored. I learned how to use a colorimeter to measure the fluoride level. I measured and recorded the fluoride level for a month and compared my findings with those of the water department. My readings averaged 1% lower than those of the water department. My last step was to demonstrate the benefit of fluoride with an analagous substance, egg shell, which contains calcium like tooth enamel. I exposed an untreated egg to a weak acid, vinegar, and fluoride treated egg to vinegar for a twelve hour period to find out what difference the fluoride made.

BIOLOGICAL, HISTOLOGICAL, AND STATISTICAL STUDY IN VIVO AND IN VITRO ABOUT ANTITUMOR ACTIVITY OF EIGHT PLANTS

RICARDO E. RODRIGUEZ-ROSA
DOCTOR SANTIAGO VEVE CALZADA
BO. SABANA, BUZON 6432, LUQUILLO, PUERTO RICO 00673

The eight extracts were tested in the brine shrimp medium. In fact, these extracts have active ingredients that kill the brine shrimp. So, the findings of this research suggest that the eight plants extracts have activity upon the brine shrimp.

The procedure determine the letal dose (LC_{50}) values in Mg/ml in order to prepare appropiate solutions to treat the mus-musculus mice that were inoculated with Ehrlich Ascites tumor cells (EAT). The mice were divided into ten groups of five mice each. There were two control groups: one was uninoculated, the second was inoculated with EAT but untreated. Each one of the others was daily treated with the plant extracts. The findings show that the eight plants are toxic to malignant cell because there were 60%-100% of supervivors.

The results of the histological study showed that the two best effective extracts are Lycopersicon lycopersicum and Catharanthus roseus. Although, all the extracts had effectiveness upon the control of malignant cells were ones better than the others. It was corroborated with the mortality trend during the first 21 days of treatment. It showed that mortality percentage varied between 0-40%.

The following plants were utilized: 1) Lycopersicon lycopersicum (L.) Karst. - Tomato, 2) Catharanthus roseus (L.) G. Don - Periwinkle 3) Brassica oleracea (L.) Capitata - Cabbage, 4) Brassica oleracea (L.) Gemmifera - Brussels sprouts, 5) Beta vulgaris (L.) - Beet 6) Sicana odorifera (Vell.) Naud. - Cassabanana, 7) Citrus limon (L.) Lemon, 8) Tagetes patula (L.) - Marigold

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STORAGE CONDITION EFFECTS ON TEST RESULTS FOR CHLAMYDIA TRACHOMATIS

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Chlamydia trachomatis, an intracellular bacterium, causes many diseases including trachoma eye disease, sexually transmissible diseases and possibly otitis media.

Chlamydia is a fragile bacterium and, when present in a specimen swab, may die if stored in adverse conditions. Conventional tests for chlamydia may therefore be falsely negative.

Australia's Aborigines have a high prevalence of both trachoma and sexually transmitted infections. In the Northern Territory, the medical organisations have problems with transporting specimen swabs the long distances from Aboriginal settlements to laboratories for diagnosis. I therefore decided to use laboratory-grown chlamydia to determine the effects of different storage conditions on the tests for chlamydia.

The diagnostic tests I chose were a new non-culture method, IDEIA (Boots-Celltech), and a conventional tissue culture method.

Specimen storage conditions were varied between five different temperatures, two vial-types, and short or long periods of time for each test method.

Storage at or below 4°C gave good results for both tests. After storage at higher temperatures, both methods gave impaired results, but IDEIA was more satisfactory. Under one of the conditions, however, polypropylene vials adversely affected the IDEIA results.

If cold transport cannot be guaranteed, therefore, use of a non-culture diagnostic method, such as IDEIA, probably gives the best chance of detecting chlamydial infection.

THE UTILIZATION OF AN ULTRAVIOLET (A) SENSITIVE BACTERIAL MEASURING SYSTEM TO COMPARE THE EFFICACY OF FOUR UVA SUNBLOCKERS: TI-SCREEN 15+, BURN-OFF 16, SUNDOWN 24, PRE-SUN 29

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It has been shown in my 1985 study, that bacterial responsiveness (growth and/or suppression) could be used as a sensitive marker for the study of Ultraviolet B light penetration through sunscreens. In my 1986 study designed to test the efficacy of a new sunblocker (Burn-Off 16) against Ultraviolet A radiation, preliminary testing showed that the UVA energy source, by itself, did not inhibit the bacteria (Staphylococcal epidermidis) even after 60 minutes of radiation exposure. In light of this finding, it was essential to develop a new bacterial measuring system before the new UVA sunblocker could be analyzed as to its effectiveness against UVA penetration.

By conjugating a photosensitive chemical (Oxasoralen) with the bacteria, it was determined that this bacterial system was rendered sensitive to Ultraviolet (A) radiation, resulting in an effective measuring tool to ascertain UVA light penetration through a sunscreen or sunblock. After proving this hypothesis in my 1986 study, this system was presently utilized to determine any differences in SPF (Sun Protective Factor) numbers of newly-produced UVA Sunblockers (Ti-Screen 15+, Burn-Off 16, Sundown 24, and Pre-Sun 29).

My findings proved that even after 60 minutes of Ultraviolet A radiation, there were no measurable differences in the SPF numbers of the sunblockers, and that each sunblocker appeared equally effective.

Thus, this reproducible laboratory model can be used for testing UVA sunblockers and possibly, utilizing the concept of chemical sensitization of cellular systems, for other future medical applications such as rendering tumors or infectious organisms more sensitive to treatment.

PDMF INDUCED TERMINAL DIFFERENTIATION OF HL-60 CELLS

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HL-60 human promyelocytic leukemia cell line is a differentiatively bipotent cell capable of selectively undergoing either myeloid or monocytic differentiation in response to chemically defined inducers. Unless the cells are neoplastically transformed, one or more growth factor supplement is necessary for growth. Recently, studies headed by Dr. M. Simonian of The University of Iowa demonstrated that human placenta contains a growth factor, Placental Derived Mitogenic Factor (PDMF), for cell cultures from the human fetal adrenal cortex.

Results from the studies of the regulation of terminal cell differentiation of HL-60 cells continuously exposed to putative peptide growth factor PDMF are reported here. Successful induced differentiation of over 70% of HL-60 cells by PDMF suggests the potential utility of peptide growth factors as an alternate modality to conventional chemotherapy by neutralizing the proliferative potential of neoplastic cells. This study also showed PDMF's diversity of target cell specificity by being able to modulate the proliferative and differentiative capabilities of hematopoietic cells. A convenient model to investigate involvement of polypeptide growth factors in terminal cell differentiation was also established.

#First Award - General Motors ISEF/Medicine and Health

#DEVELOPMENT OF NEONATAL RESISTANCE TO INFECTION: SERUM OPSONIC ACTIVITY IN BREAST-FED AND FORMULA-FED INFANTS

Sebring, Page E.
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The purpose of this study was to characterize the development of the first line of defense against infection in infants, and to determine whether or not breast feeding enhances this serum opsonic activity to *Staphylococcus aureus*. This was done by analyzing two-week-old breast-fed and formula-fed infants' serum opsonic activity to *S. aureus*, and comparing this to the opsonic activity to the same organism of control adult serum, cord serum from the infants, and serum from the infants' mothers. It was hypothesized hat the opsonic activity of breast-fed infants' sera would be greater than that of formula-fed infants, and that the opsonic activity of maternal serum would be comparable to that of control adult serum.

S. aureus was heat-killed and opsonized in serial dilutions of the above mentioned serum samples. The degree of opsonization of these particles in each serum dilution was determined by measuring neutrophil superoxide anion production in response to the opsonized particles. Appropriate positive and negative controls were utilized. There was no significant difference found between the opsonic activity of sera from breast-fed and formula-fed infants. The opsonic activity of both cord serum and maternal serum was less than the control serum, and there was no change in opsonic activity of serum from the infants at birth (cord serum) and their serum at two weeks of age.

It was concluded that breast feeding probably has no effect upon the serum-mediated primary response to infection after two weeks of breast feeding. It is apparent that maternal serum at the end of the last trimester of pregnancy has decreased opsonizing capacity which is similar to that of the mother's infant.

#First Award - General Motors ISEF/Medicine and Health

A STUDY OF THE PHENOTYPES AND GENOTYPES OF THE HUMAN EARS

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My project involved the phenotypes and genotypes of the human ears.

I got involved into this research after seeing many different characteristics in the ears of friends and family members. I wanted to know what characteristics in the ears were passed among family generations.

To start my research I looked into various references about ears to see what had already been known or/and discovered. Seeing that no extensive research had been done, I decided to pursue the subject.

To begin my research I found members of families along with other people to get pictures of their external ear. Information about the participant was recorded to see if it could be of any use. Using the pictures and the information recorded I looked for relationships among the patterns and characteristics between family members and people as a whole.

In my research I found differences and similarities within parts of the ears of the pedigrees and the other participating subjects.

#Honorable Mention - Eastman Kodak Company

CAFFEINE AND REACTION TIME TO OBJECTS IN PERIPHERAL VISION

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The purpose of this experiment is to determine the effect of caffeine on an individual's reaction time to a visual stimulus and to determine if these results are consistent with reaction time to a visual stimulus in the subject's peripheral vision.

In the first phase of the experiment, as a control, the subject concentrated on a single LED. His reaction time to seeing the LED turn on was recorded. In the second phase, the subject concentrated on a spot in the center of an oval of LED's which roughly approximated the outer limits of the subject's peripheral vision. One of the LED's, randomly selected through switchbox control, flashed on, and the reaction time was again recorded. All reaction times were automatically recorded with a computer connected to the switchbox. The tests in both sections were repeated ten times each.

The entire process was then repeated after a dosage of 200mg caffeine and then an additional 200mg had been administered to the subjects. There were 30 minute time intervals between each dose and between the tests after the doses were administered.

After the mild dosage, most reaction times quickened significantly, although the exact improvement varied somewhat between subjects. After a full 400mg of caffeine, however, the peripheral test results became very erratic compared to previous trends exhibited.

# THE EFFECTS OF ANTHELMINTIC AGENTS ON OVIS ARIES

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The purpose of the project was threefold: first, to identify and estimate the population of the tertiary or infective larvae infesting the sheep, second, to determine the effectiveness of the six classes of anthelmintic agents against the parasite population, and finally, to make a collective evaluation of the agents for commercial use.

The primary factors of importance in the procedure were fourfold: First, the collection of twenty-five independent sheep dung samples were procured. The samples were placed in cheese cloth bags and suspended in a jar for an incubation period of seven days. After incubation, the samples were baermannized for two hours for subsequent collection of the tertiary filariform larvae. Finally, the microscopically identifiable larvae were collected and subjected to the commercial anthelminic preparations. Research was performed to obtain the lethal and threshold dosage concentrations effecting the larvae in-vitro.

When the four factors were considered, the de-wormers were ranked in the order of Ivomec, Panacur, Rumatel, Thiabendazole, Tramisol, Benzelmin, and Phenothiazine respectively.

#Third Award - General Motors ISEF/Medicine and Health

DOES FACIAL CLEANSING AND REMOVAL OF TOPICAL BACTERIA ELIMINATE TEENAGE ACNE?

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PROBLEM: Acne is a major and annoying problem for teenagers. What causes acne and what is the role of topical vs. follicular bacteria in the cause of acne?
HYPOTHESIS: If acne is caused by topical bacteria, would a laboratory proven-effective antibacterial cleanser significantly eliminate teenage acne?
PROCEDURE: SpectraStat, a laboratory proven 100% bactericide, was routinely used over a 12-week period by 9 teenage participants having moderate acne. Participant photographs were taken before, during and at the conclusion of the study to observe and document skin condition and change. Observations on participants' skin condition were routinely rated and recorded. Infected pimple specimens were cultured in blood agars at 37° in a high humidity incubator and gram stained for microscopic examination. Specimens were from participants who had and who had not used the antibacterial cleanser.
RESULTS OF DATA: With routine use of SpectraStat, change in participants' skin condition was negligible. Cultures from the participants and non-participants grew identical bacteria. These bacteria (Propionibacterium Acnes) live deep in the follicle and the SpectraStat cannot sufficiently penetrate to kill the P acnes that cause acne.
CONCLUSIONS: The results do not support the hypothesis. The primary stage of acne is abnormal keratinization and excess sebum is produced which lacks linoleic acid. Testosterone increases sebaceous gland secretion. Sebum is composed of triglycerides. Propionibacterium Acnes produce lipases which catalyze the hydrolysis of the triglycerides. The product is glycerol and fatty acids which diffuse through the follicle walls causing inflammation.
TREATMENT: Systemic Therapy -- Oral antibiotics, oral contraceptives and accutane.
Topical Agents -- Benzoyl peroxide, Retin-A and topical antibiotics.
Local Therapy -- Cryotherapy and intralesional corticosteroid injection.
Rehabilitation of Acne Scars -- Collagen implant and dermabrasion.

#APPLYING THE IN SITU HYBRIDIZATION TECHNIQUE TO DETECT BHV-1 IN LATENTLY INFECTED VERO CELLS

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The most baffling characteristic of the herpesvirus is that of latency. Latency is the ability of a virus to lie dormant in the nerve cells of an animal until conditions are favorable for its replication. However, latency research can only be done in vivo. When cells in vitro are subjected to virus, they are totally destroyed, eliminating the possibility of latency. This is a major deterrent since experimentation in vitro is cleaner and less time-consuming. I have designed a procedure in which latency of the herpesvirus is drug-induced. In order for my in vitro system to be used for latency research, the gene responsible for latency in vivo must be the only active gene during latency in vitro. To determine if this possibility is correct, a procedure entitled in situ hybridization is used. In situ hybridization is the act of irradiating bases (probes) that complement the active gene's RNA exposing them on film and determining by grain counts how active the gene is. There were eight probes tested: AE, BL, D, GI, JK, SP 0.9, 0.95, and HSV. The resultant was 56 slides from which a sample of 100 to 200 cells were selected for grain counts. In order to conclude a gene as active, the probe must reveal grain counts that surpass 15 grains per cell. The probe SP 0.9 tested positive for activity. Therefore, the gene responsible for latency in the in vitro system was the same as in the in vivo system. This conclusion implies that latency research can be done in vitro.

#Fourth Award - General Motors ISEF/Medicine and Health

TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION

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Transcutaneous Electrical Nerve Stimulation, usually referred to as TENS, is successful treatment for blocking pain where other methods have failed.

The TENS system consists of a small battery-operated stimulator that generates low-intensity electrical signals. These signals are passed along wires to two or more electrodes. These direct the electric signal through the skin at the appropriate sites on the body. The surface of the electrodes should be covered with a conductive gel and firmly attached at or near the point of pain. The sites for these electrodes are usually determined by a chart that has already been established by successful placement but other sites should be tried if good results are not accomplished. The proper frequency, pulse width, amplitude and the combination of these are set through trial and error.

The TENS is a doctor prescribed method of pain treatment and requires clinical experience and judgment to apply. The individuals used in this study had been prescribed a TENS unit by their physician and each had been fitted by an experienced, trained person.

The results of my research and study on the TENS and the subjects using TENS has led me to believe that with proper application of the TENS, pain can be relieved, drug use can be reduced or ended and mobility can be restored.

It should be noted that even though medical scientific research has established that the TENS can block pain messages before they reach the portion of the brain that perceives pain, nobody knows exactly how these messages are blocked. Several interesting theories have been considered but none of these have been proven as fact.

THE VASOACTIVE EFFECTS OF ATRIAL NATRIURETIC FACTOR ON HYPERTENSION

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Hypertension is the contributing factor in many diseases that may cause death. It affects approximately twenty-one percent of the persons in the United States alone. Recently, research has delved into the possible vasodilating effects of several peptins produced by the heart on vasoconstrictors. Thus, the objectives of this investigation were: (1) To determine the correlative effects of Atriopeptin III on stroke volume, cardiac output, mean blood pressure and heart rate, and (2) To ascertain the vasodilating effects of Atriopeptin III as a possible vasoconstrictor inhibitor in hypertension.

Keeping these parameters in mind, it was hypothesized: (1) Atriopeptin III would have a definite lowering effect on the following parameters: Cardiac Output, Stroke Volume, Heart Rate and Blood Pressure, and (2) Atriopeptin III may be a vasodilating factor in the regulation of hypertension.

After careful analysis of suppositions, the following procedure was implemented: 1) The specimens (Rattus norvegicus) were anesthesized, 2) Catheterization was performed using carotid and femoral arteries and jugular vein, 3) Completed interfacing to a computer system, 4) Readings of above mentioned parameters were taken through the Cardiomax II (blood pressure indicator), 5) Additional blood pressure readings were taken, and 6) Analyses were performed on the correlated data.

Thus, it was concluded that Atriopeptin III did indeed produce a definite lowering effect on blood pressure parameters. It was also concluded that Atriopeptin III is a contributing factor in the regulation of blood pressure.

Research supported by Emory University School of Medicine.

#Third Award - General Motors ISEF/Medicine and Health

CARCINOGEN BINDING IN THE RESPIRATORY TRACTS OF HAMSTERS AND RATS

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The purpose of this study was to determine if localization of carcinogens in different regions of the respiratory tract correlates with the sites where tumors arise. This was done by investigating with autoradiography the levels of cellular binding of tritiated benzo[a]pyrene (BP) in the larynx (Lx), trachea (Tr), extrapulmonary bronchi (EPB), intrapulmonary bronchi (IPB) and terminal bronchioles (TB) of rats and hamsters at various intervals following intratracheal administration. Rats and hamsters were given BP adsorbed to ferric oxide particles (6 mg in 0.2 ml saline, containing 0.5 mCi tritium). Three animals of each species were sacrificed after 0, 3, 6, 12, 24, 48, 72, 168 and 336 hours, respiratory tracts were removed, trimmed, extracted with acetone to remove unbound BP and embedded in plastic. One um thick sections were coated with nuclear track emulsion, developed for 4 weeks, and the number of exposed grains overlying cells in the various regions were counted. Maximum BP binding occurred in rats from 0 to 3 hours following administration, but in hamsters from 48 to 72 hours. In rats, BP binding was greatest in the TB, Tr and IPB, with little binding in the Lx and EPB. In hamsters, BP binding was greatest in the Lx, Tr, EPB and IPB, with little in the TB. Rats and hamsters both develop tumors in the Tr, IPB and EPB in response to BP administration, but rats also develop TB neoplasms and hamsters develop Lx neoplasms, not found in the other species. Since significant BP binding was found in the TB of rats and in the Lx of hamsters, but not in the other species, it is concluded that sites of tumor induction do correlate with sites of carcinogen binding, and that, therefore, the abilities of cells to bind carcinogens may be an important factor in determining susceptibility to carcinogenesis in the respiratory tract.

THE PRODUCTION OF ANTI-IDIOTYPIC VACCINES FOR BRUCELLA ABORTUS: EFFECTS AND APPLICATIONS

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The problem which led to the initiation of this research concentrations on the absence of a vaccine for Brucella abortus which can be safely injected, during pregnancy, in female cows. Also a system to determine vaccinated animals from diseased animals should be developed.

It is felt that the proposed problem can be solved by the production of an anti-idiotypic vaccine.

A summarization of the procedures used are as follows:

1. Inject two calves with chemically killed Brucella abortus (Strain 19).
2. Extract the antibody from the vaccinated calves serum.
3. Inject the emulisfied (calf) antibody into a horse and two chickens.
4. Extract the anti-antibody (also termed anti-idiotype) from the horse serum and chicken egg whites.
5. Emulisfy the anti-idiotype to produce an oil based vaccine which will be used to attempt immunizing a calf for Brucella abortus.

The results, as shown by agglutination and other standard Brucellosis tests, determined that the anti-idiotypic (both horse and egg origin) caused an immune reaction in a calf, similiar to those produced by calves vaccinated with the standard Brucella abortus (Strain 19) vaccine.

In conclusion, the product of this research is an anti-idiotypic vaccine that has the potential of replacing the standard Brucella abortus vaccine, due to the fact that it is safe, effective and possesses an identification system for vaccinates based on.

#Fourth Award - General Motors ISEF/Medicine and Health

# DEVELOPMENT OF A CLONOGENIC ASSAY IN THE R3327G PROSTATIC ADENOCARCINOMA

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Prostatic Adenocarcinoma in the rats and the improvement of the efficiency and accuracy of cancer study in this system through the use of a new method are described. A model for human malignant prostatic cancer is established in rat studies by the creation of an artificial metastasis in rats. If the suspended prostate tumor cells enter the rat's circulatory system via a vein, where would they most likely colonize? The lungs would presumably be the most likely place because they provide the first mechanical constriction, the capillaries, to trap the cells. Secondly, the lungs provide a suitable media for cells to grow and establish themselves. A chemical process is produced to clear the lungs (artificial metastasis) so that accurate and efficient quantitation, and correlation for potential developing tumor cells in order to determine the maximum therapeutic ratio of tumor cells by applying some therapeutic techiniques are possible. Rat lungs are removed from the rat and are passed through a series of clearing-staining procedures. This method allows an accurate and efficient quantitation of tumor number and size.

Chemical adjustments were made, and a new method for the study of prostate cancer and its artificial metastasis was established. Preliminary study to establish a correlation between the number of lung colonies and the number of injected cells was negative with an injection of 10^6 cells and a 21-day incubation period . This would be pursued by applying various combinations of incubation period and cell quantity.

This assay makes it possible for chemotherapy and testing techniques to be developed for the human prostate cancer through rat studies. It provides an accurate method for the analysis of potential tumor cells.

#First Award - Eastman Kodak Company

BIOASSAY TO DETERMINE TERATOGENICITY IN CLOVE CIGARETTES

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The purpose of this experiment was to determine the teratogenic effects of clove cigarette smoke on the development of chick embryos. Also, these effects were compared with those of regular cigarette smoke. To conduct this assay, thirty fertile chick eggs were separated into three groups: clove, tobacco, and control. On the third day of incubation, each egg in the clove group was injected with a clove solution, whereas the tobacco group was injected with a tobacco solution at the same time the clove group was injected. After injection, all thirty eggs were incubated until the eleventh day of incubation, when the first comparison of development was performed. Five eggs from each group were opened for comparison. Observed were bone structure, beak and eye development, length, weight, and other statistics. The remaining eggs in each group continued incubation until the twentieth day when the second comparison was made. The same aspects observed in Comparison 1 were again observed in Comparison 2 with the addition of an internal comparison by means of dissection. It was observed that half of the chicks in the clove group resulted in embryonic death while the other half developed gross bodily defects. Defects of bone development, eye and beak structure, limb and internal defects were found to be prevalent in the clove group. Also, abnormalities in the tobacco group were detected similar to those in the clove group; however, the severity of the defects and the extent to which the defects were found to be in the tobacco group were not as severe as the defects observed in the clove group. From this assay, it was learned that clove cigarette smoke is much more teratogenic than regular cigarette smoke.

#ELECTROPHYSIOLOGICAL INSTABILITY IN HUMAN ISCHEMIC MYOCARDIUM - RELATIONSHIP TO CHRONIC CIGARETTE SMOKING

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The purpose of this research project was to determine the the critical role of chronic cigarette smoking, in: a)the production of ventricular arrhythmias following Acute Myocardial Infarction (AMI, heart attack), b) the degree of cardiac muscle damage following AMI, and c) the association between ventricular arrhythmias and cardiac muscle dysfunction following AMI. A total of 18 patients were divided into 4 study groups - 1. Normal Control Group A (non smoker subjects without known heart disease) 2. Normal Control Group B (chronic cigarette smokers without known heart disease) 3. Experimental Group C (non smoker survivors of recent heart attack) 4. Experimental Group D (chronic cigarette smokers and survivors of recent heart attacks).

All subjects underwent a) 24 hour Ambulatory Electrocardiography (Holter monitoring) and b) Real Time Two Dimensional Echocardiography. The former was to evaluate cardiac arrhythmias and the latter analyzed the cardiac wall motion and function.

Conclusions: 1. Ventricular arrhythmias were most prevalent in the cigarette smoking survivors of heart attacks (Grp D) - statistically significant(P= .02). 2. Cardiac Dysfunction was most prevalent in this same group- statistically significant (P= .01). 3. There is a positive correlation between ventricular arrhythmias and cardiac muscle dysfunction, following a heart attack.

#First Award - Federal Aviation Administration
Fourth Award - General Motors ISEF/Medicine and Health

CAN CORTISONE PLUS HEPARIN INHIBIT GROWTH OF CARCINOMA IN MUS MUSCULUS

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The purpose of this project was to determine if Ehrlich Ascites Carcinoma, when implanted in the rear right hip of BDF1 mice, can be inhibited by the treatment of subcutaneous-injected cortisone acetate plus subcutaneous-injected sodium heparin. The treatment's duration was 14 days.

The regimen for the subcutaneously injected heparin was 627 U/kg every 24 hours. The regimen for the subcutaneously injected cortisone acetate was 250 mg/kg every 24 hours.

Beginning on Jan. 2, 1987 the mice in all three groups (group A, which consisted of five mice with no cancer and no treatment; group B, which consisted of five mice with cancer but no treatment and group C, which consisted of five mice with cancer but treated with heparin plus cortisone) were massed every four days using a double pan laboratory balance.

Massing the mice was begun four days after the cancer was injected subcutaneously in the mice and six days before the treatment was started.

On Jan. 23, the mice in groups B and C were sacrificed by inhalation of ether and the tumor-bearing hind legs and non-tumor-bearing hind legs of the mice were massed and preserved. The tumors were then measured with a caliber to find the volumes using the formula $vol=(d_1 d_2 d_3 \pi)/6$.

After running a statistics test on the mean tumor volumes and masses of the two groups it was concluded that there is strong evidence toward the fact that cortisone acetate plus sodium heparin can inhibit the growth of Ehrlich Ascites Carcinoma.

# EYEROBICS: A NEW CONCEPT IN BODY BUILDING?

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The purpose of my experiment was to determine whether exercising the eyes' muscles improved their performance in depth perception and tracking related skills. Depth perception refers to how the eyes work together in order to judge the closeness of an object, whereas tracking is how the eyes are able to follow an object traveling through space.

My hypothesis consisted of two points. First, I predicted that if I tested a group of subjects before and after they had exercised their eye muscles, there would be a significant improvement in the eyes' performance in both of the skills tests. Second, I predicted that this improvement (for the exercised persons) would be much greater than any improvements by the control (non-exercised) subjects.

After designing the tests and gathering results, I found that:

1. The test subjects showed an increase in both their eye muscle compatibility and coordination.
2. The improvements by the test subjects in the skills tests were significant; changes in the performance of the control subjects were non-significant.

There are numerous practical applications to my project. Since eye muscle exercising improves depth perception and tracking skills, it would help pilots, athletes, policemen, automobile drivers, and others. By improving the eyes' ability to work with each other, it may also lessen eye strain and reduce headaches. Eye exercises should not be overlooked by anyone wishing to have a completely fit body.

#Honorable Mention - American Optometric Association and the Auxiliary to the American Optometric Association

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ANALYSIS OF THE THERAPEUTIC EFFICACY OF COMMONLY USED ANTIHELMINTICS

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Throughout each year veterinarians and horse owners are faced with the constant problem of equine parasites. This project analyzes the therapeutic efficacy of five commonly used antihelmintics (febantel, pyrantel pamoate, fenbendazole, ivermectin, and oxfendazole) in the removal of strongyles and *Oxyuris equi*. Experimental groups, horses who received normal deworming treatments, and a control group, horses who remained untreated, were established.

Pinworm samples and fecal samples were collected on a weekly basis from each horse, and these t tests were conducted as follows: microscopic analysis of slides prepared from pinworm sampling and flotations as well as Baermanns was prepared from fecal samples to determine the number and types of strongyles present. The results indicated that the antihelmintics were therapeutically effective against *Oxyuris equi* and strongyles but to varying degrees. The percentage removal of *Oxyuris equi* eggs at posttreatment week 1 for each antihelmintic is as follows: febantel 94%; pyrantel pamoate 92%; fenbendazole 97%; ivermectin 84%; and oxfendazole 94%. Likewise, at posttreatment week 1, the percentage removal of small strongyles for the antihelmintics are as follows: febantel 100%; pyrantel pamoate 97%; fendendazole 100%; ivermectin 94%; and oxfendazole 97%. The percentage removal of *Strongylus vulgaris* for each antihelmintic is as follows: febantel 100%; pyrantel pamoate 100%; fenbendazole 100%; ivermectin 85%; and oxfendazole 97%. Invermectin's reduced efficacy is attributed to the fact that it is available over-the-counter as an intraoral paste, which in comparison to antihelmintics administered by a stomach tube, is less effective against equine parasites.

#ENKEPHALINASE: WHERE IS IT?

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Neutral metalloendopeptidase (NEP) can function as an enkephalinase. In other words, it has the ability to cleave enkephalin, a neuropeptide involved in pain perception. However, besides being found in the nervous system, this enzyme has also been found in other parts of the body. Therefore, it is conceivable that it may have other functions. In this study, the enzyme was to be localized precisely in the human prostate gland, where its presence had been suspected through light microscopy. NEP was also to be localized in the rat prostate and intestine. Immunocytochemistry using colloidal gold was employed, not only to prove the presence of NEP, but also to specify on the electron microscope level the exact region of the cell in which NEP is produced. The procedure involves prparing ultrathin sections of frozen tissue and incubating the tissue slices with an antibody to NEP. A secondary antibody carrying a gold label is then applied. In the electron microscope, the gold particles appear as black dots, showing where NEP is located. Another technique was also used to prepare the tissue for viewing under the light microscope. This technique is known as silver enhancement, and consists of binding silver particles to the gold particles, thus forming dots big enough to be seen under the light microscope.

Neutral metalloendopeptidase was found to be associated with the cell membrane of the alveolar lumen in the human and rat prostate. It was also present in the rat intestine.

#Fourth Award - General Motors ISEF/Medicine and Health
Honorable Mention - Eastman Kodak Company

DETERMINING THE PHYSICAL, MENTAL, AND PSYCHOBIOLOGICAL EFFECTS OF FOOD PRESERVATIVES ON THE MUS MUSCULUS

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To determine the physical, mental, and psychobiological effects of food preservatives on the Mus Musculus was the objective of this project. The food preservatives used were; monosodium glutamate, dioctyl sodium sulfosuccinate, butylated hydroxyanisole, butylated hydroxytoluene, tartaric acid, sodium acetate, and propylene glycol. Forty Mus Musculus were used in this experiment, one male and two females per preservative. Exposure to the preservatives began three weeks prior to the start of research. Tests consisted of field study, maze learning (to study hyperactivity), external observations, tests for weight gain or loss, observations of internal changes. Tests showed that both parent and offspring, when exposed to monosodium glutamate, dioctyl sodium sulfosuccinate, propylene glycol, tartaric acid, butylated hydroxyanisole, butylated hydroxytoluene, and sodium acetate were hyperactive and had lost weight. Both the parent and offspring who were exposed to propylene glycol possessed a withdrawn attitude, and had gained weight. External characteristics appeared dark in color, and rough in texture in those Mus Musculus exposed to butylated hydroxytoluene and propylene glycol. Through further research, it may be determined that these food preservatives could have similar effects on human behavorial patterns.

The Effects of Nicotine on White Blood Cell Morphology, Cell Population and Sister Chromatid Exchanges

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In this study, selected concentrations of nicotine (1.02 mg/kg/day, 2.28 mg/kg/day) were used to produce measurable or observable variations in white cell number and morphology in rats.

Fifteen rats were divided into three groups of five. One group was the control, one the 1.02 mg/kg/day nicotine group, and one the 2.28 mg/kg/day nicotine group. The rats were administered liquid nicotine for 18 hrs. and fresh water for 6 hrs. per day. The water consumption was monitored at every water changing. Once a week blood was taken from the tail and used for differential stains and lymphocyte cultures.

The cells were cultured using a GIBCO Diagnostic Chromosome Reagent kit for 72 hrs. at 37 degrees Celsius. Colcemid was added during the final 3 hrs. The cells were then treated with KCl and a methanol.acetic acid fixative. Slides were prepared and stained for evaluation.

90 differential slides and 21 cultures have been produced. 210 slides of cells and chromosomes have been evlauated. The 2.28 group's monocyte population was significantly increased over time as compared to the control group. The water consumption of the nicotine rats was significantly increased during the day time as compared to the control group. The 2.28 group significantly consumed more water than that of the 1.02 group in the day and in the night. This suggests that the 2.28 group became addicted to the nicotine. Although the culture technique was perfected, the sister chromatid exchange count procedure will be developed in the next phase.

This research is important in providing a quantitative and qualitative estimate of the effects of nicotine on lymphocyte morphology number and type and potential mutagenic effects.

THE EFFECT OF RETINOIC ACID ON THE PRODUCTION OF ACETLYCHOLINE IN VIVO STUDIES

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Alzheimer's disease, a dementing neurodegenerative disease, has been shown to involve a loss of cells, which synthesize acetylcholine in the brain. Retinoic acid, a vitamin A derivative, can increase the activity of the enzyme, which synthesizes acetylcholine, choline acetyltransferase (ChAT) in human cell culture. This result was used as a basis for investigations to determine whether retinoic acid would increase ChAT activity in vivo.

Five mice were injected with retinoic acid and five with vehicle over five days. The mice were sacrificed, the brains were dissected, and a ChAT assay was then performed. The differences in ChAT activities between experimental and control groups were statistically insignificant. A similar experiment was performed using rats. Thirteen rats were fed a retinoic acid deficient diet, and twelve rats were fed a supplemented diet. A unilateral brain lesion was made after three weeks to reduce cholinergic function in the basal forebrain, to parallel Alzheimer's disease. Three and six weeks following the brain lesion, the rats were sacrificed, dissected, and assayed for ChAT activity. An analysis was done, and again retinoic acid did not significantly increase ChAT activity. The results obtained demonstrate the effectiveness of the lesion, but do not show that retinoic acid increases acetylcholine levels in mice or rats. These results imply that either the experimental design was insufficient for measuring the differences in ChAT activity or that retinoic acid has no effect on ChAT activity in this system.

#A Comparison Of Lactated Ringers And Sodium Bicarbonate On Blood pH In Canine Surgery.

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A common problem when animals undergo surgery is the effect the anesthesia has on the pH of the blood.To help stabalize blood pH, a buffer may be given intravenously during surgery. This research is an investigation into the effects of lactated ringers and sodium bicarbonate as buffers on the prevention of metabolic and respiratory acidosis/ alkalosis during canine surgery.

12 female dogs in good health were divided into three groups; control, lactated ringers, sodium bicarbonate. Each animal underwent the same type of surgery. Pre and Post surgical blood samples were collected at equal time intervals from the femoral artery. Body temperature was kept constant through the use of a heating pad. The experimental groups were given the buffers intravenously throughout the surgery under very controlled weight related application.

Using the Henderson Hasselbalch equation equation graph there was slight difference. The control showed respiratory acidosis before surgery and metabolic acidosis after surgery. The two experimental groups were in respiratory acidosis both pre and post surgery. In both the sodium bicarbonate concentration increased to the buffers given intravenously. Using ANOVA analysis (analysis of variation) however there seems to be no significant difference in the control group or either of the two experimental groups.

The results show that either buffer will be just as effective in maintaining the normal blood pH but neither is needed to do so because the control group is stable.

#First Award - American Veterinary Medical Association

RAT MAMMARY GLAND DEVELOPMENT AND CARCINOGENESIS (abbreviated title)

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Although rat mammary carcinogenesis studies have suggested that the level of development of a mammary gland may play a role in its susceptibility to carcinogenesis, the development of the rat mammary glands has been studied neither quantitatively nor in all six pairs of the rat's mammary glands. The purpose of this work was to quantitate mammary gland development occurring with puberty and age, and to compare development among different pairs of glands within an animal, in order to determine if the degree of development of a mammary gland is indeed an important factor in its susceptibility to carcinogenesis. Wholemounts of mammary glands from four groups of virgin, female, Sprague-Dawley rats ranging in age from 21 days (prepuberal) to 117 days (sexually mature) were studied using light microscopy and an Image Analysis System. Development was quantitated primarily by counts and measurements of terminal end buds (TEB), which are the most undifferentiated structures in the mammary gland. Statistical analysis using Student's t-test showed that the second and third (thoracic) mammary glands lagged behind in development, which coincides very well with the high incidence of carcinoma in those glands. The highest proportion of TEB occurred in the prepuberal animals, and decreased with age, which also coincides very well with published data on carcinoma incidence with respect to age and puberty. Thus, this quantitative study strongly suggests that the level of development of a mammary gland is a determining factor in its susceptibility to carcinogenesis, and that the development of the pairs of mammary glands within the female rat is not simultaneous. These findings should have significant implications in breast cancer research, prevention and treatment.

#First Award - American Medical Association
First Award - General Motors ISEF/Medicine and Health

EFFECTS OF ACEPROMAZINE MALEATE ON C. GALLUS EMBRYO

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The purpose of this project is to determine that a tranquilizer, Acepromazine Maleate, slows down or stops the growth of a C. gallus.

First, the incubator was set up and the temperature of thirty-five degrees Celsius (One hundred one degrees Fahrenheit) was established. Then, fourteen fertile C. gallus eggs were placed in the incubator. The eggs were observed by candling until the ninth day of incubation. At that point, Acepromazine Maleate, a tranquilizer, was injected into the top of the embryo of six fertile C. gallus eggs. At the same time, sterile water was injected into the top of the embryo of six fertile C. gallus eggs. Both groups were then placed back into the incubator for the remainder of the incubation period. On the sixteenth day of incubation, the injected C. gallus eggs were opened, pictures were also taken at this time.

It was concluded that the tranquilizer Acepromazine Maleate affected the growth of a C. gallus embryo by either stunting or slowing down the growth of the C. gallus embryo.

One of the six C. gallus eggs injected with the tranquilizer Acepromazine Malleate contained some growth. It was found that the C. gallus was developed to day fourteen when it was opened on the sixteenth day of incubation. The normally clear membrane was cloudy and very thin.

The five remaining C. gallus eggs that were injected with Acepromazine Meleate showed day nine development. It was observed that the yolk sac was broken and was an orange color rather than yellow. The normally clear membrane contained yellow particles.

In the eggs injected with sterile water, there was normal growth.

# A STUDY OF THE INHIBITORS OF THE $RLT_{21}(L^6)$ TUMOR

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Metastasis is the spread of cancer from a primary tumor to other organs in the body. The purpose of this research has been to develop a procedure that will effectively test substances thought to have antimetastatic properties. Three substances were tested for such properties: catechin, catechin-copper complex and a lung extract (catechin and catechin-copper complex were found to not inhibit metastatasis). The lung extract, previously shown to be antimetastatic in humans, was tested to determine the validity of the procedure developed. The lung extract was antimetastatic in this procedure as well, indicating the probable effectiveness of the procedure for testing substances though to antimetastatic.

The analytical procedure was initiated by innoculating subject rats with the $RLT_{21}(L^6)$ tumor. The tumor was allowed to grow and mature for two weeks. After sacrificing the animals, the liver and lungs were removed. The liver plasma membrane was assayed to help assess the state of the extracellular matrix. Lung spots, indicative of metastasis, were counted to determine the inhibitory effect of the substances on metastasis.

The results of this research indicate that the catechin and the catechin-copper complex did not inhibit metastasis, despite an increase in copper content in the blood. However, the lung extract showed significant inhibition of the metastasis. Similar positive results are being achieved with tests of a tri-peptide, indicating the effectiveness of the procedure in testing the substances.

#Fourth Award - General Motors ISEF/Medicine and Health

SHORT TERM EFFECTS OF CAFFEINE ON HEART RATE AND ENDOTHERMAL ACTIVITY OF HUMANS

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I conducted an experiment to determine the short term effect of caffeine on the heart rate and endothermal activity of humans. My hypothesis was caffeine will speed up heart rate and raise skin temperature of humans fifteen minutes after consumption. I later proved this hypothesis wrong. The beverage was Coca-Cola Classic and Caffeine Free Coke. I chose the Apple IIe computer and computer program "Bio-Feedback" to obtain my data. I also incorporated exercise in the tests. I chose eight human subjects, three females and five males, ranging in weight from 110-160 pounds. I used a series of six tests. All my tests had a trial before consumption of the beverage, ten minutes after consumption and fifteen minutes after consumption. My first test was with no beverage or exercise. The subjects were tested for heart rate and skin temperature. The second test tested the subjects with the consumption of caffeinated Coca-Cola Classic. The third test determined the subjects' heart rate and skin temperature after the consumption of Caffeine-Free Coca-Cola. Test 4 was the first of three tests with exercise involved. The amount of exercise was five minutes at a speed of 15 mph with a tension setting of two on an exercise bike. Test 4 did not have subjects drink a beverage and was used as a baseline similar to Test 1. Test 5 involved the subjects drinking caffeinated Coca-Cola Classic with exercise. Test 6 involved the drinking of Caffeine-Free Coca-Cola with exercise. The results of my experiment showed that caffeine slowed heart rate and decreased skin temperature and Caffeine-Free Coca-Cola increased the heart rate and increased skin temperature.

THE LYTIC ACTIVITY OF COMPLEMENT

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Complement is a series of proteins that interact as an enzyme cascade and function as an immune effector of the acute inflamatory response. Activation of the complement system on the surface of cells results in the production of membrane alterations which may lead to cell death. Complement is not a single substance; it is a complex of nine proteins that interact with one another. These proteins are numbered C1 to C9. Two parallel but completely independent mechanisms or pathways lead to the biologically important portion of the complement sequence. These mechanisms are termed the classical and the alternate pathways. The initiation reaction of the classical pathway lies soley in the activation of C1. C1 is activated by interaction with certain antigen-antibody complexes. The pathway consists of three operationally defined function units: the recognition unit (C1), the activation unit (C4, C2, C3), and the membrane attack unit (C5, C6, C7, C8, C9). The alternate complement pathway differs from the classical pathway in that it bypasses C1 and is activated by complex polysaccharides instead of antigen-antibody reaction. This pathway plays an important role in host defense against invasion by bacteria and some fungi. The antigen-antibody reaction resulting from mixing blood group A red blood cells with blood group O serum will be used to illustrate the classical pathway. _E. coli_, which contains polysaccharide in the cell membrane, will be used to activate and demonstrate the alternate pathway. Both experiments clearly demonstrate the role complement plays in cell lysis and host defense.

MICROBIOLOGY

A STUDY OF THE RELATIVE TOXICITY OF SECOND-HAND SMOKE ON CELL GROWTH USING IN VITRO CELL CULTURE TECHNIQUES

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The purpose of this research was to determine the relative toxicity of second-hand smoke on cell growth.

Baby hamster kidney cells were cultured. Smoke extract was collected by a smoking machine. When enough cells had grown to complete a run of the experiment. The cells were collected and counted. Five different dilutions of smoke treated media were added to the cells. The cells were then placed in a carbon dioxide incubator for 48 hours, before being collected and counted again. These experiments were repeated sveral times to insure accuracy.

The data was compiled and analyzed. By comparing the growth ratio of cells treated with first-hand smoke to cells treated with second-hand smoke, it was determined that second-hand smoke was 25% as toxic as first-hand smoke. Also, smoke treated media in general had two effects on the growth of cells. At low concentrations cell growth was stimulated: but at high concentrations, cell growth was inhibited.

There appeared to be two major morphological changes caused by smoke extract. Firstly, smoke treated cells became large in size and irregular in shape, when compared to the control cells. Secondly, the smoke treated cells showed a tendency of clumping together. The smoke treated cells grew in patches and on top of each other in contrast to the control cells that grew in an even monolayer.

#First Award - U.S. Air Force

STUDY OF THE INHIBITION EFFECT OF ESPECIMEN ON CANDIDA ALBICANS

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Among the fungus there is Candida Albicans a Demorphic, Pathogenic, opportunistic causing mycotic infection in human. I try to control it's growth "In Vitro" with nineteen mililiters of infusion (fifty grams of speciment in a hundred mililiters of water) of plants leaves, algae, condiments, vegetables, five to fifty per cent of sugar solution concentration and salt solution to cultives, inoculated on Nickerson and Maicocell agar at thirty seven degree centigrade. In a lapse time of ten days, I noticed that some of the speciment shows an inhibition effect in the fungus. In search of what cause the inhibition effect I make a biochemical analisis to the infection separating the organic from the inorganic composition adding dicloromethane and methane. I try the phases for inhibition effect on Candida Albicans, applying nineteen mililiters of each phase to cultive inoculated on Nickerson and Maicocell agar at thirty seven degree centigrades. in ten days I observed that the organic phases has the inhibition effect. These phases and the infusion that shows the inhibition effect were analiced by an infrared instrument and liquid cromatography.

#THE ECOTYPIC VARIATION OF *ESCHERICHIA COLI* WITH RESPECT TO ANTIBIOTIC SENSITIVITY FROM ANNE ARUNDEL COUNTY WATERSHEDS

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The purpose of this investigation is to determine if *Escherichia coli* is developing an acquired resistance to antibiotics through artificial selection. Antimicrobial agents are present in our environment and have multiple utilizations. Antibiotics are used extensively in medicine and they are sprayed on crops to protect the plants against infectious diseases. Most animals receive antibotics on a daily basis to accelerate their growth and to keep them healthy. The agents are also used as food additives and preservatives. There is a genuine concern that the liberal use of subtherapeutic levels of clinically useful antibiotics is a threat to human health.

Twenty-four water samples were collected from creeks in Anne Arundel County, Maryland with excessive fecal contamination (high coliform counts). *Escherichia coli* in these samples was identified, isolated, and cultured using the coliform count, IMViC tests, and Gram staining, in conjunction with *Bergey's Manual of Determination Bacteriology*. The Kirby-Bauer technique was then applied to comparatively determine the degrees of antimicrobial susceptibility to thirteen specific antibotics. The results were analysed to determine the differentiations.

Through the experimentation which was executed a conclusion may be drawn which supports the hypothesis. *Escherichia coli* found in Anne Arundel County watersheds is developing a resistance to specific antibiotics through artificial selection. *E.* coli which was isolated from Mill Creek and Marley Creek displayed complete resistance to chloramphenicol and novobiocin at the given concentrations. The judicious use of antimicrobial agents could extend their clinical life, so that they may continue to be used in the treatment of disease.

#Fourth Award - General Motors ISEF/Microbiology

# WHAT ATE DAD'S TENT?

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This study was done to find out if fungi isolated from soil can decay cotton threads and if enzymes produced by the fungi can digest cellulose. The idea for the project came from the rotting of a cotton tent left out in warm, damp weather.

Fungi were isolated both from partly rotted tent fabric and from rotted raw cotton that was incubated with soil. All of the eight fungi tested reduced the breaking strengths of cotton threads. Not all of the fungi reduced the breaking strengths the same amount, though. Only three of the eight fungi caused clearing of cellulose agar, an indication of cellulase production. Thus, it was demonstrated that fungi isolated from rotted cotton fibers or tent fabric can cause rot of cotton fabric as represented by cotton threads. They probably do this by producing cellulases. Fungi probably were responsible for rotting of the tent left out in damp weather.

Knowledge of which fungi rot fabrics and how they do it could lead to improved methods of controlling them or reducing activities of their enzymes. Identification of organisms that produce more active cellulases also could lead to improved digestion of cellulose by cows, and maybe even to production of sugars from cellulose for food.

#Third Award - General Motors ISEF/Microbiology
Honorable Mention - National Association of Biology Teachers

AN INVESTIGATION INTO THE IDENTIFICATION OF BACTERIA THROUGH DNA BASE CHROMATOGRAPHY

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This project investigates the development of an effective identification method for microorganisms through a chromatography analysis of their DNA base.

During the course of this research, a wide variety of bacteria were utilized due to their unique and diversified characteristics. Two different procedures were used to extract the DNA from the remaining cellular materials. Upon completion of the DNA isolation, a Thin-layer Chromatography analysis was conducted as the basis for a comparative study.

It is believed that an effective bacterial identification method can be facilitated through a chromatography analysis of numerous bacterial species. Since bacteria possess individual physiological traits, it is only logical that they possess different DNA combinations. It is also believed, with the success of this research, that the process of identifying unknown bacterial species will substantially increase not only in accuracy, but also in time efficiency.

INHIBITORY EFFECTS OF GARLIC, ONION, RADISH ON FOOD SPOILAGE

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Allium cepa, commonly known as onion, *Allium sativum*, garlic, and *Raphanus sativus*, radish, contain compounds that have antimicrobial activity. It was hypothesized that different concentrations of extracts would inhibit the growth of various food-spoiling bacteria and fungi.

Bacillus subtilis, *Rhizopus nigricans*, and *Neurospora crassa* were the specific organisms tested. Twenty petri dishes and twenty-four test tubes with Sabouraud dextrose agar and broth and ten petri dishes and twelve test tubes with nutrient agar and broth were used to cultivate the organisms. The petri dish experiments employed the disk-agar diffusion method to test the susceptibility of each organism to each extract's antimicrobial activity. Disks saturated with 0,20,40,60,80, and 100% concentrations of an extract were placed in the dishes. The second set of experiments used the tube dilution turbidity method to test the sensitivity of the organisms to lower percentages of onion and radish extract. The tubes were examined macroscopically and microscopically to determine the inhibition coefficients. Six other general experiments were conducted in which normal foods, including breadcrumbs, cheese, fruit punch, pasta, wheat bread, and white bread, were doused with extracts. The diameter of the zones of inhibition on the petri dishes and the presence of growth in the test tubes were recorded daily. Except for the dishes of *R. nigricans*, every organism was affected by *A. cepa*. Garlic and radish also showed a wide variety and range of inhibition. The limited results indicate that garlic, onion, and radish (somewhat) are effective in inhibiting the growth of the microorganisms tested, and may, in the future, possibly be tested to be used as food preservatives.

THE EFFECT OF LIGHT ON CELLULAR SLIME MOLD PSEUDOPLASMODIAL MIGRATION

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Cells reach a multicellular state by several different routes, one of which is the aggregation of free-living cells to form a multicellular structure. Cellular slime molds, particularly Dictyostelium discoideum are one of the more interesting examples of this course to multicellularity. This study deals with the morphogenic stage of the D. discoideum, specifically pseudoplasmodial (slug) migration and attempts to determine if these slugs respond to an external light source. Isolation of the species is the first step in studying these animals, but this process was unsuccessfully attempted. Therefore, freeze-dried spores were obtained and placed on a 0.3% lactose-peptone agar medium. The plates were grown in an environment with no illumination with the exception of brief periods when their progress was observed. Eventually, the cells reached a stage in which they came together and formed a finger-like structure called a pseudoplasmodium. This experiment included observations of the pseudoplasmodia movement toward a beam of light placed at varying degrees. 180° and 90° changes initiated immediate responces from the front (apex) of the slugs which turned to move in the direction of the light's new location. Twenty minute, 45° angle changes equalling a full circle movement also prompted undelayed responce. In all cases, the apex of the slugs searched to find a sufficiant source of illumination. It can therefore be noted, that Dictyostelium discoiduem species of cellular slime mold pseudoplasmodia are strongly phototactic and that this characteristic plays an important role during their migration.

EFFECTS OF VARIOUS DIAMINE OXIDASE INHIBITORS ON NITRIFICATION

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The purpose of this study was to (1)improve a previously developed culture system for nitrification allowing continuous assay of nitrate production,(2)determine the effects of various diamine oxidase inhibitors (DAOIs) on nitrification and (3)search for evidence of a diamine oxidase system in nitrifying bacteria.

Modified batch cultures of a proprietary preparation of nitrifying bacteria in Engel-Alexander nitrification medium were maintained at 29°C a pH of 7.2 with sterile aeration in a closed vessel. A nitrate ion selective electrode coupled to a pH meter and strip chart recorder traced potential changes for 24 hours.Thirty-two runs were made.Four runs without DAOIs served as control for twenty-four runs challenged with six DAOIs at 10^{-3}M.Four runs challenged with the natural diamine putrescine at 10^{-3}M were controlled by corresponding time segments within unchallenged runs.An electrode calibration curve was constructed to determine nitrate concentrations for twelve datum points in each run. Specific nitrification rates,n',(specific growth rates),doubling times and total nitrate production were calculated.Inhibition or acceleration was expressed as a percentage of control n'.

My principle findings were: (1) all six DAOIs inhibited nitrification to varied extents(1.5 to 87.7%),(2) putrescine-challenged runs demonstrated a brief period of accelerated nitrate production(232%) and marked turbidity preceded by inhibition(54.9%) and followed by uninhibited nitrification(100%).This suggests adaptation of nitrifying bacteria to putrescine and (3)hypothetically oxidative deamination can be linked with ammonium oxidation in Nitrosomonas.

This evidence suggests the presence of a diamine oxidase system in nitrifying bacteria.

* OBTAINING T4 MUTANTS: HOW? WHY?

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Mutant T4 bacteriophage specific for AAA and UGA suppressors in *Escherichia coli* were obtained in this experiment through spontaneous and chemical mutagenesis. These mutant phage were identified using a double layer technique similar to that of Reid and Berg (1968). With these phage, bacterial strains with any of the previously mentioned suppressors can be identified overnight. Before, this process would have taken up to two weeks of genetic experimentation.

*First Award - U.S. Army

THE EFFECT OF DESINFECTANTS IN THE DEVELOPMENT OF ESCHERICHIA COLI

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Public opinion research done on use of sanitary desinfectants and tests done in labs on the efficiency of these in the destruction of Escherichia Colibacteria.
It was confirmed that advertising influences to a great extent the choice of the product and as in Brazil the veracity of advertising is not controlled by public authorities the consumer is subject to the usage of low quality products but with a high publicity appeal.
It was proven that even the powerful desinfectants lose their efficiency when mixed with water.
As consumers use these in toilets and drains with water deposits the desinfectant becomes diluted and totally ineffective as bacteriocides.
They simply become perfumes.
Conclusion: What is sold as a bacteriocide does not have this quality in practice.

EFFECTS OF PLANT EXTRACTS ON THE GROWTH OF TUMORS

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The popularity of the medicinal plants use for the treatment of carcinogenic tumors and my worry for the lack of scientific basis to support such practice, motivated me to get involved in this research. The *Pativeria alliacea* and *Plantago major* extracts were administered by topical application to well-grown tumors after inoculation with *A. tumefaciens*. A dilution of bacteria and extracts was injected on tomato plants to measure the capacity of the extracts to inhibit the development of the tumors. The results show that the *Pativeria alliacea* extract has a delaying effect during the first stages of tumors growth in a major scale than the *Plantago major* extract. When applied locally, neither of the extracts affected the growth after that stage. Cultures of extracts and bacteria were done, using the spectofotometer. The Petri Plate cultures showed tha the *Pativeria alliacea* extract doesn't inhibits the growth of the bacteria and that the *Plantago major* inhibits some strains of it.

THE ANTIMICROBIAL EFFECTS OF PYOCYANIN EXTRACTED FROM *P. aeruginosa*

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The purpose of this project is to extract pyocyanin from *Pseudomonas aeruginosa*, prove that this has antimicrobial activity against some bacteria and fungi, and to compare pyocyanin activity with routine antibiotic sensitivity testing. I subcultured *Pseud. aeruginosa* to Mueller-Hinton agar to induce the formation of pyocyanin pigment. The bacterial growth was suspended in sterile H_2O, placed in a separatory funnel, and $CHCl_3$ was added. The pyocyanin layer was removed and treated with HCl. The pyocyanin pigment was tested against 10 bacterial suspensions equivalent to a 0.5 McFarland standard. The tests were performed on Mueller-Hinton and blood agar. A series of biochemical tests were done on *Pseud. aeruginosa*. Gram stains were performed on all bacteria used for testing. The following bacteria showed zones of inhibition when tested with pyocyanin: *E. coli*, *Staph. aureus*, *Staph. epidermidis*, and *Proteus vulgaris*. Pyocyanin "sensitivity" tests were performed on discs and in wells on agar plates. The zones of inhibition were directly proportional to the quantity of pyocyanin used in the test area. Sensitivity studies were done against all test organisms using antibiotics commonly known to inhibit the specific bacterial organisms. These studies included pyocyanin as one of the antibiotics used in the sensitivity tests. Conclusion: In my testing pyocyanin inhibits *E. coli*, *Staph. epidermidis*, *Staph. aureus*, and *Proteus vulgaris*. In sensitivity testing, pyocyanin showed zones of inhibition approximately equal to zones produced by the other antimicrobial discs. Therefore, pyocyanin has the potential to be used as an antimicrobial agent against some species of microorganisms.

#Second Award - Patent and Trademark Office/U.S. Department of Commerce/
Patent and Trademark Office Society
Third Award - General Motors ISEF/Microbiology

THE ACTIVITY OF ALANYL tRNA SYNTHETASE IN *E.COLI* MRE 600

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The purpose of this experiment was to determine the relationship between the rate of growth of *Escherichia coli*, strain MRE 600, and the activity of alanyl tRNA synthetase present in the culture. Alanyl tRNA synthetase was studied because it, being an aminoacyl tRNA synthetase, plays a major role in the production of proteins. It was hypothesized that as the rate of growth increased, the bacteria would require more proteins; therefore, the activity of the enzyme, alanyl tRNA synthetase, which catalyses this reaction, would also increase. In order to test this hypothesis the growth curve of *E. coli* MRE 600 was established. Samples were then taken at five points along the growth curve: one from the lag phase, two from the early log phase, one from the mid log phase, and one from the late log phase. The growth of the bacteria in the samples was stopped by pouring them into a buffer solution; and the samples were then pelleted twice, once at 5000 RPM for fifteen minutes and once at 10,000 RPM for ten minutes. The pellet was then sonified to release the enzyme from the cells. The activity of alanyl tRNA sythetase was determined by placing the bacterial extract containing the enzyme in a tube where it would react with C14 alanine, thereby picking up the radioactive label. Radioactivity was then measured in a scintillation counter. Results showed that as the bacteria grew the activity of the enzyme, measured in nanamoles per milligram of protein, also increased from 21.6 to 37.6. And, when the bacteria was in the stationary phase the activity decreased to 16.8. Thus these results support the hypothesis that alanyl tRNA synthetase activity is indeed linked to bacterial growth.

DEGREE OF CONTAMINATION OF THE POPULAR FOOD ITEM KNOWN IN PUERTO RICO AS "CARNE AL PINCHO"

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In Puerto Rico the sale of pork meat "pincho" has been very popular in ambulatory public stands in the last few years. The objective of this research was to study the microbial population of "pincho" meat at two locations: Mayaguez and Moca. Five public stands in each town were sampled weekly during five months. Cultures for fungi and bacteria of the family Enterobacteriaceae were made. The media used for the fungi were Potato Dextrose Agar (P.D.A.) with Chloranfenicol, Tetracyclin and Rose Bengal. Plates were incubated during five days at 27°C and followed by subcultures of each of the type of colony found. *Candida* sp. found in each of the samples was cultured separately. The biochemical tests for identification of bacteria were carried out using fresh cultures. The media used for bacterial counts was: Plate Count Agar and Violet Red Bile Agar. The plates were incubated for 24-48 hours at 35°C.

The organisms identified in the cooked meat according to *Bergey's Manual of Determinate Bacteriology* correspond to the following genera: *Salmonella*, *Proteus*, *Enterobacter* and *Citrobacter*.

The sampling of the cooked meat showed significant amount of bacteria. The pathogenic organisms: *Salmonella arizonae*, Typical *Salmonella*, *Shigella sonnei*, *Escherichia coli* and the environmental contaminant *Proteus mirabilis* were found in numbers well over the limits indicated by the *Association of Official Analytical Chemists* (AOAC) and by the American Public Health Association (APHA).

Raw meat yielded the same genera but in larger numbers. The sauce was negative for the presence of bacteria. Sampling also revealed the yeast *Candida* sp., the fungi *Penicillum* sp. and *Cladosporium* sp., all of them opportunistic microorganisms. Typical *Salmonella* and *Escherichia coli* cause gastroenteritis an infection of human beings, and *Proteus mirabilis* causes bacterial infection (Bergey's Manual, 1984).

#Second Award - General Motors ISEF/Microbiology
Honorable Mention - American Society for Microbiology
Honorable Mention - Eastman Kodak Company

CELL DETERMINATION OF *DROSOPHILA MELANOGASTOR*

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At what stage of development do cells become determined to such an extent that they differentiate autonomously and independently of surrounding cells. To answer this question I hypothesized that somatic and reproductive cells of the Drosophila, as an example, are determined in the early larval stage. I formulated this hypothesis on the basis of research which pointed out that in the Drosophila larva exist clumps of cells called imaginal disks. Most of the adult fly develops from these disks. To find out if the disks were present at every stage of development I used a microscope. At 400X magnification I noted that all larval Drosophila, even at the earliest stages, contained imaginal disks. Were the disks already determined (set in their growth pattern)? Yes they were. I determined this by transplanting the disk of a larva in the earliest stage into another larva. The implanted disk had come from the larval position of a prospective first leg and, after implantation, differentiated into a leg. This proved that in the larval stage cells were already determined. After noting this fact, I experimented one stage lower, on the blastula. Transplantation experiments similar to those on the larvae proved that took place between the early and late stages of blastulal development. This conclusion indicated that my hypothesis was false, although close to the mark. Cell determination did not take place during the larval stage, but rather during the blastulal stage.

IN VITRO AFFECT OF MOUTHWASH ON GROWTH OF ORAL MICROORGANISMS

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Seven national brands and four store brands of mouthwash were chosen at random and tested for antimicrobial activity against oral microorganisms *in vitro*. Three percent hydrogen peroxide, and 1% salt water were also tested. Four concentrations of each preparation were tested(undiluted, 1:2, 1:4, and 1:8). The two-fold dilutions were made in sterile distilled water, then 1/2" sterile paper disks were saturated with each dilution, and placed on blood agar in 15 X 150 mm petri dishes previously seeded with a "lawn" of oral microorganisms. Oral microorganisms were obtained by swishing and gargling 40 ml of sterile distilled water for 1 minute and expectorating into a sterile container. Antimicrobial activity was determined by measuring the diameter of the zones of inhibition surrounding the disks on the blood agar plates. No inhibition was observed around a control disk containing only sterile distilled water. Eight mouthwash products exhibited zones of inhibition surrounding one or more dilutions and appear to be statistically different in effectiveness at a 95% confidence level. Three mouthwash products and the 1% salt water exhibited no inhibition. The largest zones of inhibition were measured around disks containing dilutions of 3% hydrogen peroxide.

"C" - A VIRUS DEFENDER?

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This project was done to determine whether vitamin c had an inhibitory effect on the attacks of a bacteriophage.

The procedure began by preparing trypticase soy mediums and autoclaving them to insure sterility. Following this, broth was poured into test tubes, agar was poured onto plates, and soft agar was put into a hot water bath to keep it from solidifying. Then a dilution series to 10^{-8} was done for each bacteriophage and .2 ml of the specific E.coli strain was added to each dilution of the phage. This E.coli strain was previously cultured in 1000 mg of vitamin c. The mixtures were then shaken vigorously and poured onto agar plates. These plates were then incubated and the results were recorded.

It was found that the number of plaques formed after the use of vitamin c was considerably less than that of the control. It was also found that as the dilution increased the number of plaques decreased.

DRUG RESISTANT *E. COLI*

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The purpose of this investigation was to determine if a strain of the bacteria *E. Coli* resistant to one antibiotic was also resistant to other antibiotics. This was done by using the antibiotics Erythrocin, Gentamicin, Ancef, Polycillin-N, and Cleocin Phosphate and the disc susceptibility testing procedures. The resistant colony was found in the plate containing the antibiotic Cleocin Phosphate, by diluting the antibiotics, inoculating prepared plates of agar, placing medicated discs on the plates, and incubating the plates until a resistant colony was found. The resistant colony was then incubated and used when repeating the procedure. The colony was not found to be resistant to the other antibiotics.

DEVELOPING AN ACID-RESISTANT STRAIN OF *Bacillus anthracis*
a three year study

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PURPOSE: This project is a continuation of a three year study of *B. anthracis*. The purpose is to differentiate a strain of *B. anthracis* by repeatedly cultivating it in vitro on acetic nutrient agar, and as a result, to exacerbate the strain to the point that it is resistant to environmental factors such as acidic conditions, alkaline conditions, or antibiotics and phage. A sub-purpose of this project is to study exactly what kind of bacteriophage attacks *B. anthracis*, how this phage affects it, & how repeated growth on acidic affects the activity of the phage on the cell.
PROCEDURE: Four sets of tests are performed with 3 plates in each test: pH 1.5, pH 4.0, pH 6.0. The first set of plates is inoculated with a Sterne's strain suspension of *B. anthracis*. Then the 2nd set of plates is inoculated from the 1st test & so on. The plates are incubated for 24 hrs. & subjected to the following tests: Gram stain, penicillin sensitivity, string-of-pearls, & bacteriophage lysis test. It was also necessary to perform a streak for isolation when a possible contaminant was found in Test 3. Electron micrographs were taken of suspensions of *B. anthracis*, phage, & the phage + bacteria.
RESULTS/CONCLUSIONS: Growth in pH 6.0 & CO2 produced a variant that was resistant to the phage. The phage was inactivated but not unattached, and the DNA is still injected into the cell. The phage DNA may be passed down to bacterial offspring.
The inactivated phages could be used to implant specific enzymes in the bacteria causing it to produce enzymes which break down other pathogenic *B. anthracis* strains. This strain could be used as a type of vaccine that directly destroys its own kind. The phage could be used to disengage other types of Bacilli if those types were also susceptible to the particular phage used.

A STUDY OF THE ANTIBIOTIC EFFECT OF FRUIT JUICES

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This research investigated fruit juices as possible bacterial suppressants in an attempt to verify and explain the beneficial use of cranberry juice as a home remedy for relieving the symptoms of urinary tract infections (UTI).

A fixed amount of fruit juice was consumed over an eight hour period, and urine specimens were collected at regular time intervals. The specimens were inoculated with bacteria and incubated for 48 hours at 35°C. A UV-Vis spectrometer was used to compare the turbidity (due to bacterial growth) of the test samples with that of the controls.

Of the juices studied, all but pineapple resulted in suppression of the bacteria studied (E. coli, Alpha Streptococcus and Staphylococcus). The pH levels of the specimen correlated closely with the beneficial effect of the juices. The consumption of 250 ml of fruit juice at 4 hour intervals with a normal diet was found to give a significant amount of bacterial suppression for a 150 lb male. Testing for bacterial growth in a 10% solution of fruit juice in urine was found to be an effective means of screening fruit juices for antibiotic activity.

This research provides a scientific basis for using cranberry juice in treating UTI and suggests that other fruit juices may be equally beneficial. In addition, the results may further the understanding of some of the difficulties experienced in identifying the bacteria responsible for UTI.

# ANTIMICROBIAL AGENTS IN THE CONTROL OF CITRUS CANKER

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Citrus canker has been the worst disease that has yet affected the citrus industry, and has permanently arrested development of crops in more than 2/3 fo the world. Some research has been done to find different methods of control of this disdease, but because of strict laws, experimentation using the causative agent had been banned in the U.S.A.

Citrus canker is caused by *Xanthomonas citri*, a gram negative bacterium, described as being a short, motile rod with rounded ends and a polar flagellum. Since use of this bacterium has been banned, a model organism *Xanthomonas campestris* (non-pathogenic to citrus), was used. It is a closely related variety that may yield promising results without endangering citrus industries. Bacteria of such nature could easily be controlled using specific concentrations of antibiotics.

Fifty antibiotics were tested, and six showed promising results. These were augmentin, ceftizoxime, chloromycetin, erythromycin, imipenem, and vancomycin. These were selected by susceptibility-disk testing with kill zones ranging from 17mm to 34mm. A growth curve on thses antibiotics was conducted using the Spectronic 20. All the antibiotics were successful, but only augmentin and erythromycin were utilized in the plant and soil evaluations. It was found that the antibiotics in no way affected the natural cycles in the environment, and therefore human ingestion factors will be investigated. This will be the final step in determining a more efficient method of control. .

#Second Award - American Phytopathological Society
Third Award - General Motors ISEF/Microbiology
Honorable Mention - American Society for Microbiology

#IDENTIFICATION OF A POTYVIRUS USING FILTER PAPER IMMUNOBINDING ASSAY

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The purpose of this investigation is to know the new immunobinding assay technique in the identification of a potyvirus in green pepper plants (*Capsicum Annuum*) in Puerto Rico.

The potato virus Y (a potyvirus) was identified affecting a small home orchard of green pepper plants. The identification was based on the presence of the viral inclusions in epidermic plant cells using the light microscope and the filter paper immunobinding assay which consist in the entrapping of the antigen or viruses using a filter paper, producing a precipitate as an indicator of the presence of a potyvirus in green pepper plants in Puerto Rico.

The potato virus Y (potyvirus) in *Capsicum Annuum* plants culture in Puerto Rico was present in eight of our twelve samples. These techniques developed by scientist from the University of Florida and the Research Station Agriculture of Canada are simple, economical, reliable and rapids to use for diagnostic of plant viruses in undeveloped countries.

#Fourth Award - Gneral Motors ISEF/Microbiology

*PRESENCE OF CRYPTOCOCCUS NEOFORMANS AND SEROTYPES IN SAN JUAN

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Cryptococcus neoformans, a yeast, has been linked with the soil and pigeon droppings and is the cause of cryptococcosis, a deep fungal disease of the brain and meninges. C.W. Evans isolated this fungus from soil and pigeon dropping samples, and later identified three types of it. Later studies confirmed this close relationship and uncovered a fourth serotype. These serotypes are found to be different in their morphology, habitats, and epidemiology. Pigeons are carriers of this fungus; a place where they are abundant is a risk for people if Cryptococcus neoformans is found in the creatinine-rich droppings. The disease cryptococcosis is also found to be different when the serotype of the fungus is different. The purpose of this research is to attempt to isolate C. neoformans from Pigeon's Park in Old San Juan (Phase I) and to determine the frequency of each serotype in San Juan (Phase II). Using simple laboratory tests developed by different scientists and qualitative observation, various samples from Pigeon's Park and local patients with cryptococcosis were studied. Based on the biochemical and physiological characteristics of the isolates in both phases, it was determined that there was no Cryptococcus neoformans in Pigeon's Park as of November, 1984. Also, it was determined that in late 1986, the most common serotype in San Juan was serotype A (C. neoformans var. neoformans). This research serves as the basis for further studies of the presence and serotyping of Cryptococcocus neoformans on the Island.

*Fourth Award - General Motors ISEF/Microbiology

RELATIONSHIP BETWEEN 3-KETOLACTOSE AND PHOSPHATIDYL CHOLINE PRODUCTION TO T-DNA TRANSFER BY AGROBACTERIUM TUMEFACIENS

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Of great importance in basic genetic engineering techniques, the gram-negative bacteria known as Agrobacterium tumefaciens infects the members of over 40 families of dicotaleginous plants. The usefullness of these mircoorganisms stems from their ability to transfer a segment of their plasmid DNA into the genomes of plant cells where the genetic code of the plasmid is expressed. Two characteristics known to be unique to Agrobacteria are high concentrations of phosphatidyl choline and the production of 3-ketolactose from lactose oxidation.

The concentrations of phosphatidyl choline in infected tissue, non-infected tissue, and in bacterial suspensions were determined by absorption spectrometry after extraction and purification by preparitive chromatography. The ability to synthesize 3-ketolactose was tested in all three sample types by a simple oxidation reaction in a disaccharide complex.

Statistical analysis of the data collected yielded much higher concentrations of phosphatidyl choline in infected tissues than in equivelent masses of non-infected tissue and bacteria (an increase of 1996%). Only the bacterial suspensions yielded positive test results indicitive of 3-ketolactose production.

From the data collected, it was concluded that only the characteristic for phosphatidyl choline synthesis was passed into the plant cells, possibly to initiate an increase in transport of nutrients across cellular membranes to support the higher metabolic rate of infected cells.

INTERACTION OF SELECTED METALS AND ANTIBIOTICS ON *B. SUBTILIS* AND *E.COLI*

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The previous year's study concluded that the effect of the interaction of selected metals and antibiotics on *B. subtilis* resulted in the enhancement of the growth of the bacteria; whereas, the opposite effect was noticed when *E. coli* was grown in the presence of the same combinations.

The purpose of the current study was to determine the cause of the antibiotic reversal which was evidenced in the previous study. It is hypothesized that the metal and antibiotic combine to form a chelate, and therefore cause the resultant reversal. This possibility was tested using a Cary 17 (spectrophotometer) and scanning the visible spectra of both the metals and antibiotics separately. This same procedure was used to test the chelate mixture. Tests will also be conducted on both the ultra violet and infrared sections of the spectrum.

Through studies already conducted, eight of the metal- antibiotic combinations appear to have formed a chelate. Three of the chelates can be identified using the visible spectra. Five more combinations appear to form a chelate. This was determined by the formation of a white precipitate when two clear solutions were mixed. The precipitate reveals that a reaction has occurred. It is known that ninety percent of the time when a ligand combines with a metal, it will form a chelate structure. Further studies are presently being conducted on other sections of the spectrum in an attempt to locate these chelates.

COMPARATIVE AND CHEMICAL STUDY "IN VITRO" AND "IN VIVO" OF THE BACTERIOSTATIC EFFECTS OF *PETIVERIA ALLIACEA*, *ALOE VERA*, *MOMORDICA CHARANTIA* AND *CASSIA ALATA* IN FOUR PATHOGENIC BACTERIAS

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Today many medicines come from natural products including medicinal plants. Do plants, such as, *Petiveria alliacea*, *Aloe vera*, *Momordica Charantia* and *Cassia alata* have bacteriostatic effects on *Escherichia coli*, *Proteus vulgaris*, *Pseudomona aeruginosa* and *Staphylococcus aureus*? The extracts were prepared in five different concentrations: 1 g/2.0 ml, 1 g/1.0 ml, 1 g/0.5 ml, 1 g/0.3 ml and 1 g/0 ml (0.2 cc) of these concentrations were dropped in four aliquots of bacterial suspension. The remaining suspension was considered as the control group. Observations of turvidity and colony counts were made after 24 hours of incubation. According to observations, the extract concentrations which most reduced the bacterial growth were 1 g/1.0 ml and 1 g/0.3 ml. In *E. coli*, *Petiveria* inhibited 32% of its growth. In *Proteus*, *Momordica* reduced 48% of its growth. In *S. aureus*, *Petiveria* reduced 43% and in *Pseudomona*, *A. vera* inhibited 44% of its growth. In the "in vivo" test, mice were exposed to the bacteria and given liquid leaves extract. According to the physical changes in the mice, the extract of *Petiveria alliacea* and *Aloe vera* reduced the abscesses induced and allowed regrowth of hair. The Api 20E test on Gram-negative bacteria revealed the posibility the extracts had changed the bacterial biochemistry patterns. Also, the beta-hemolysis of *S. aureus*, revealed the posibility that the extracts had changed to alfa-hemolysis. The analysis showed that the *Petiveria alliacea*, *Aloe vera* and *Momordica charantia* extracts in the 1 g/1.0 ml and 1 g/0.3 ml concentrations demostrated to be more effective as bacteriostatic agents.

#CONTROL OF PATHOGENIC FUNGI BY M.I.C. OF ANTIMICROBIAL AGENTS.

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The purpose of this investigation is to compare the effectiveness of Botran, Benlate, and Calcium propionate in controlling *Rhizopus* and brown rot of peaches, establish their minimum inhibitory concentration, and determine which agent is most active against both rots.

The development of fungicides to protect the peach crop improved the control of *Rhizopus* and brown rot, but lately fungal resistance has become an important problem. An ongoing search for new ways to control the rots is necessary, and a potential control is the use of preservatives as fungistatic agents.

The hypothesis of this investigation is that Calcium propionate will have the greatest effect in inhibiting the growth of *R.stolonifer*, Benlate having the greatest effect on *M.fructicola*.

The initial procedure of the investigation was to prepare inoculum in a sterile environment and produce a specific spore suspension. Experimentation in specially designed glass tubes determined the growth rate of each fungus, affected by various concentrations of the agents.

The conclusion of this investigation, in comparing the effectiveness of Botran, Benlate, and Calcium propionate, determined that the M.I.C. of Botran for *R.stolonifer* is .0007813%, for *M.fructicola*, .05%. The M.I.C. of Benlate for *R.stolonifer* is .8%, for *M.fructicola*, .025%. The M.I.C. of Calcium propionate for *R.stolonifer* is 2%, for *M.fructicola*, .4%.

Technically, Botran was the most active against *R.stolonifer*, Benlate the most effective against *M.fructicola*, but the drawbacks of high cost, toxicity, and the current state of resistance to the fungicides, leads to the conclusion Calcium propionate is overall, most effective.

#First Award - General Motors ISEF/Microbiology
Third Award - American Phytopathological Society

THE EFFECTIVENESS OF HANDSCRUBBING ON BACTERIAL GROWTH

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The purpose of this experiment was to show the effect of handscrubbing on bacterial growth, based on the number of organisms on unwashed hands and in distilled water.

Under sterile conditions, four volunteers scrubbed their hands into basins of sterile water for various lengths of time. Each volunteer then streaked three Petri dishes with their clean fingers. Using an inoculating loop, three additional dishes were streaked with water from each basin. The plates were incubated at 37°C for twenty-four hours. The plates were checked for growth and the data was recorded.

Based on the gathered data, the amount of bacteria in the water increases as handscrubbing time increases. The amount of bacteria on the hands decreases as handscrubbing time increases.

In conclusion, handscrubbing can be effective in removing bacteria from the hands if done properly for a long enough period of time.

THE USE OF SUCROSE TO DIFFERENTIATE ESCHERICHIA COLI IN FRESHWATER

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The presence of coliform organisms in a water sample has been regarded as evidence of fecal pollution and has served for many years as a basis for water-quality criteria. When environmentalists test a body of freshwater and locate Escherichia Coli, there is not a definite procedure to identify the E.coli's origin. As a result, environmentalists can not prove where pollution is coming from, whether it be from septic tanks in a residential area, a sewage treatment plant's overflow, or a cow pasture. Past research has shown that human and cow E.coli's reaction to certain sugar solutions can be used to separate the two types of E.coli. Last year's data proved that a sugar solution containing Sucrose and brom cresol purple broth, by the 7th hour of incubation, 100% of the time, can differentiate human and cow E.coli separately. A solution containing Melibiose and brom cresol purple broth by the 7th hour of incubation 75% of the time identified human E.coli and 100% of the time identified cow E.coli. This year's research included two different phases of experimentation in order to prove last year's results correct. In phase one, experiments were repeated from last year with human and cow E.coli separately tested with the Sucrose and Melibiose sugar solutions. In phase two, the E.coli from a combined broth containing both human and cow E.coli colonies was tested with the Sucrose and Melibiose sugar solutions. In the final phase of experimentation, E.coli from freshwater samples was tested with the Sucrose and Melibiose sugar solutions with the E.coli's origin determined.

#First Award - Sigma Xi, The Scientific Research Society
Third Award - General Motors ISEF/Microbiology
Honorable Mention - American Society for Microbiology

DETERGENT CONCENTRATION AND DEVELOPMENT IN THE SEA-URCHIN

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In the present work, we have determined the effect of different concentrations of an anionic, biodegradable detergent dissolved in sea-water, on the formation of the fertilization membrane of the sea-urchin **Lytechinus variegatus**. Urchins were collected from Araçá Beach in São Sebastião, São Paulo State, Brazil, and transported to the Department of General Physiology of the Institute of Biosciences of the University of São Paulo, in styropor boxes covered with algae to maintain humidity. Three experimental series were performed, each consisting of 6 groups of 20 eggs at different detergent concentrations, using a total of 20 animals. A lethal concentration (LC_{50}) of 4.0 ppm was found where only 50% of the ovules formed a fertilization membrane. At this concentration, the remaining eggs showed a tendency to improve development after 48 h, indicating a possible reduction of the detergent effect with time due to degradation. The detergent may act on the cell membrane, disorganizing the protein layer, thus disturbing control over the entrance and exit of cellular material. It may also cause loss of activity in the spermatozoa.

SELECTIVE STUDIES OF NEMATICIDAL EFFECTS IN PLANT EXTRACTS

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This project consists of experimenting with nematicidal effects of selected plant diffusates on selected nematode feeding types. The two plants chosen for this study were marigold (Tagetes erectus) and rye grass (Secale cereale) because they are suspected to emit exudates into the soil which act as a deterent to nematodes. The nematodes selected for this study were Rhabditis, because it is a common saprphytic nematode and M. incognita because it is one of the most damaging parasitic nematodes in terms of costs to farmers. It was hypothesized that the extracts of plant diffusates would react non-selectively toward parasitic and saprophytic nematodes. The procedure was as follows: Rye grass was allowed to decompose in 100 mL of distilled water for 3 months. The initial residue was filtered through a millipore system to remove contaminants and then reextracted with ether. Marigolds approximately 10 cm in heighth were allowed to diffuse in 100 ml of distilled water for 72 hours. This liquid was similiarly refined. Each day for one week, 1 ml of diffusate was placed on petri dishes inoculated with the selected nematodes. At 24, 48, 72, and 168 hours, viability tests were conducted in which 100 nematodes were counted and recorded as viable or non-viable. Chemotaxis test were also performed. It was found that while the rye grass extract was a much more powerful nematicide, the extract of marigold diffusate was the better of the two because it is specific to parasitic nematodes. Since chemotaxis was found to be negative for both extracts, it was suggested that while marigold diffusate may not be toxic to saprphitic nematodes, it may act as a deterent.

Development of Rhizobium Hybrids Through Isolation and Manipulation of DNA

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This investigation attempts to develop a new strain of Rhizobium capable of inducing nitrogen fixating nodules on the roots of selected grains.

Modern methods of crop production often produce higher yields of important grains. This increased production can also involve large costs in providing sufficient amounts of the required fertilizers. The purpose of this research is to not only provide a new method of of increasing the production rate, but also to put these costs on a decline.

Rhizobium, a bacteria found in the roots of legumes, will be crossed with Gibberella zeae, an Ascomycete that plagues corn roots, developing a hybrid. To begin the procedure, two types of bacteria, Rhizobium leguminosarum and Rhizobium meliloti, and the fungus, Gibberella zeae, will be cultivated to produce the large quantities needed. Each of the two Rhizobium strains will be processed through the use of two extraction processes to isolate the DNA. Using seven separate combinations, the recombinants will be formed. Corn seeds will be germinated and planted. The recombinants will then be applied to their roots. After a period of time, the roots will be checked for nodules and the soil tested for an increase in nitrogen content.

Many possibilities are present in such an investigation. They include the formation/non-formation of nodules, fixation of nitrogen, and fungal infection of the corn. Although formation of nodules and fixation of nitrogen is hoped for, it is the hypothesis that there will be some amount of fungal infection to the roots from the Gibberella zeae.

ENZYME REPAIR OF UVR INDUCED DAMAGE IN BACTERIA

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The purpose of my experiment is to observe the effects of UV light on bacteria and how their repairing mechanisms work.

In order to accomplish this, I elaborated a procedure in which samples are drawn at intervals from a population of bacteria irradiated by ultraviolet light. The samples are plated on nutrient agar and the colonies that form are counted.

From this experiment, I found that colony-forming ability decreases as the dose of irradiation time increases.

However, at high irradiation times, a series of random results are the base of my hypothesis centered in the damaging capability of the ultraviolet light. After long time exposures, there is a small number of resistant bacteria left when all the susceptible cells have already been killed. The existence of resistant bacteria explains the random results found, and my hypothesis favors the idea that cells with fewer thymine bases are a favorable variation that decreases the possibility of UV damage and because of this, increases the resistance ability of the cells.

A further testing of the resistant cells was done by treating the survivors with a second dosage of UV light. The results obtained show that the number of cells recovered after the second exposure is very high, which can explain my hypothesis of the existance of resistant cells. However, there are few cells killed and that could be explained by assuming the possibility of mutations and the possibility of damage in the repair systems themselves.

NATURAL PRESERVATIVES

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The purpose of this project was to test the effectiveness of 10 natural preservatives on beef, and to determine how well each of these work as a germicidal agent on cultures of bacteria.

Prepare 10 natural preservatives and apply them to ten plates of beef that have been previously cut up into squares. Allow them to sit out at room temperature for 24 hrs. Swab the meat and smear onto blood agar plates. Place plates in incubator for 24 hrs. at 37 C. Count bacterial colonies on each plate and record colony count.

Prepare cultures of *E. coli*. Place one untreated disc and three discs that have been treated with one preservative to each plate with the untreated disc being used as a control. Place in incubator for 24 hrs. at 37 C. Measure the zone of inhibition and record results.

The results indicated that lemon juice and cloves were the best preservative, while cayenne pepper was the worst. They also indicated that vinegar was the best germicidal agent.

Of all the natural preservatives tested, lemon juice was the best overall preservative and germicidal agent, while cayenne pepper proved to be the worst natural preservative in both categories.

# TOBACCO MOSAIC VIRUS

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The purpose of my project was to study the effects of TMV on cabbage plants using different compounds, environments, and innoculation methods. In my first series of experiments, I tested to see which environments hinder the growth of TMV and which help it. I performed five experiments consisting of a constant dark, constant light, normal, constant heat, and a constant cold. Each experiment had an infected plant (variable) and an uninfected plant (control). All experiments were observed daily for six days.

In my second series of experiments, I used different compounds to determine which helped or hindered the growth of TMV. I performed a vinegar experiment, a baking soda experiment, and a milk experiment. Each experiment had an infected plant using a compound (variable) and an infected plant without the compound (control). I also performed a normal experiment where the variable was infected, but the control was left uninfected. This series was observed for ten days.

In my third series of experiments, I utilized different methods of innoculation. I performed four experiments consisting of an experiment using a syringe instead of my original innoculation method, a sodium phosphate and a sodium nitrate experiment where I placed each compound into separate solutions, and a normal experiment which had an uninfected control. This series was observed for ten days. I used 1 gram and ½ gram doses for my two compound experiments.

#Fourth Award - General Motors ISEF/Microbiology

#"Studies on the Netplankton on Lake Biwa" — Effects of ultraviolet ray and phosphorus on the deformation of Pediastrum biwae —

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Lake Biwa, the largest lake in Japan, has been polluted for about 30 years. I cultured the plankters on Lake Biwa in the laboratory to know the effects of water pollution. And I also sampled plankters in Lake Biwa at a monthly interval from 1981 to 1986 to estimate water pollution.

Pediastrum biwae is an endemic phytoplankter in Lake Biwa. I cultured *P. biwae* under several conditions and found that high phosphorus concentration and ultraviolet ray deformed *P.biwae*. I studied on the cause of deformed *P. biwae* thoroughly. The deformation is classified into three types. The proportion of deformed *P. biwae* in Lake Biwa increased until 1983 and was constant thereafter. This suggests that eutrophication was going on until 1983.

I selected nine dominant plankters of Lake Biwa and cultured them simulating the natural conditions. I succeeded in reproducing the natural seasonal change in abundance and classified them into eutrophic and mesotrophic species. The abundance of eutrophic species in Lake Biwa increased until 1983. This is consistent with the above suggestion that eutrophicaion was going on until 1983.

I found that acid water reduced the abundance of plankters in the laboratory and observed that plankters became less abundant after rainfall in Lake Biwa. Therefore, acid rain is a cause of the reduction of plankters.

I conclude that eutrophication and acid rain affect the plankters of Lake Biwa. I report only the sudy on deformation on the panel, but I have the other results with me to show you.

#First Award - General Motors ISEF/Microbiology

THE EFFECTS OF CAFFEINE ON THE GROWTH AND HEMOLYSIS OF STAPH AUREUS

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This project was used to show any hemolytic or growth effects that caffeine could have on Staphylococcus aureus, and any effects that caffeine itself might have by itself.

It was hypothesized that the caffeine would stimulate growth in the Staph aureus, thereby increasing hemolysis because the Staph aureus would need more of the nutrients from the blood. Also, the caffeine should not be hemolytic by itself.

The bacteria was grown in a CO_2 environment at 37° Celsius for 48 hours. Then, serial dilutions of the bacteria were made in sodium chloride solution (0.9%). To accomplish this, three sets of five tubes with 10 ml of solution had solution removed to create a suspension. Form the first set, 5 ml was removed. From the second set, 1 ml was removed. From the last set, 0.1 ml was removed. The removed solution was made into a suspension of Staph aureus, then the suspension was replaced in the tubes in equal amounts to the amounts previously removed. The caffeine was then added to the tubes in the following manner: A 25 mg/ml solution of caffeine was made, one tube from each group was removed as a control, thenn the caffeine was added in amounts of .4, .8, 1.2, 1.6 ml, or 10, 20, 30, and 40 mg of caffeine. The bacteria was exposed fro 30 minutes, then a drop from each tube was placed on a blood agar dish and incubated in a CO_2 environment for 48 hours at 37° Celsius. The results were recorded and graphs were made of the results.

The results showed that the caffeine decreased the growth of the hemolysis in the Staph, but the size of the bacteria had not been changed.

The conclusion that was arrived at was that caffeine decreases hemolysis through a chemical change in the bacteria, rather than a physical one.

Future research will inculde finding and isolating the activation site for the caffeine in the Staph aureus, and changing the gene to permit greater hemolysis or the total deactivation of hemolysis.

MECHANISTIC STUDIES OF CELL FUSION INDUCED BY MURINE LEUKEMIA VIRUSES

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Virus induced cell fusion is of considerable biological importance. Many viruses have been reported to induce fusion. The newest of these is the virus responsible for the AIDS disease (HTLV-III). In this paper, a new system for studying the cellular interactions involved in retroviral-induced cell fusion is described. It was also shown that the interaction of ecotropic Murine leukemia virus-infected cells with cells infected with either dualtropic or amphotropic Murine leukemia viruses results in the novel effect of spontaneous fusion without the need of any membrane modifying reagents. Preliminary studies of the mechanism of this fusion are reported as well. The possible involvement of the dualtropic external glycoproteins was tested by examining the ability of antisera with varying specificity to inhibit fusion. The results indicated that these glycoproteins (gp65 and gp70) do not have a functional role in inducing fusion of this system. A new hypothesis is introduced to explain the mechanism of this fusion. This hypothesis relates membrane fluidity with the ability to fuse. In order to asses the validity of this hypothesis, studies were conducted by examining the fusion inhibiting activity of interferon on fusion of this system. The results cannot yet be used to determine the validity of the membrane fluidity hypothesis. Additional studies are required. Understanding the mechanism of virus induced cell fusion may allow for the development of drugs capable of interfering with this process. Such drugs may be useful in treating certain cytopathic virus infections such as AIDS.

#First Award - Tissue Culture Association
Second Award - American Society for Microbiology
Second Award - General Motors ISEF/Microbiology

ANTIBODY-DEPENDENT ENHANCEMENT OF MACROPHAGE INFECTION BY LACTATE DEHYDROGENASE-ELEVATING VIRUS

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Lactate dehydrogenase-elevating virus (LDV) is a mouse virus which raises the levels of certain enzymes in the blood. In old or immunosuppressed mice, it can also cause paralytic disease. LDV was studied to determine if it exhibits antibody-dependent enhancement (ADE) of infection. ADE results when virus particles bind to host antibodies, and the antibodies bind to host macrophages which engulf the complex by phagocytosis. Instead of destroying the virus, however, the macrophage itself becomes infected. ADE has been demonstrated in other members of the family Togaviridae besides LDV. In this experiment, LDV was bound to ether-extracted immune mouse plasma and allowed to infect peritoneal mouse macrophages in cell culture. The percent infected cells was determined by autoradiography using tritiated uridine and actinomycin D, and also by indirect immunofluorescence using immune mouse plasma and monoclonal FITC-conjugated rabbit anti-mouse IgG. An experiment was also done to determine if a trypsin-sensitive receptor was involved in the infection of the macrophages. LDV exhibited signs of ADE but the role of a trypsin-sensitive receptor could not be ascertained from the data.

#First Award - American Medical Association
First Award - U.S. Navy
Alternate to London International Youth Science Fortnight Trip - U.S. Navy

WATER POLLUTION: VARIATIONS IN LIGHT INTENSITY AND THE EFFECTS ON SKELETONEMA COSTATUM

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Skeletonema costatum is a phytoplankton--a collective term for organisms that live suspended in the sea and in bodies of fresh water. Many factors affect their growth, sunlight being the most vital because they are photosynthetic. Suspended particulate matter, including anthropogenic (man-made) material, can decrease the amount of light available for the growth of phytoplankton. Statistics show that in the cleanest marine environment 83.9 percent of the light is absorbed within the first ten meters of the water column. In oceans that have an abundance of suspended particulate matter, 99.5 percent of the light is absorbed at the same depth. The growth rate of Skeletonema costatum is directly proportional to light intensity.

This experiment tested the degree to which a reduction in light intensity would affect the growth rate of Skeletonema costatum. Five Erlenmeyer flasks, each with 200 ml of Skeletonema in culture, were exposed to different intensities of light: 150, 60, 25, 10, and zero footcandles. The flasks produced from 3×10^4 cells/ml to 6×10^3 cells/ml respectively. Therefore, if there is a buildup of suspended particulate material in the waters of a marine environment, due to either natural or man-made conditions, then the reduced available light could cause a decline in the concentration of phytoplankton. This could upset the natural balance of the environment, as phytoplankton produce 80 percent of the world's oxygen and form the productive base of both marine and fresh water ecosystems, providing food for larger animals and indirectly for man.

IDENTIFYING AND TRANSFERRING A GENETIC REPAIR MECHANISM IN MAMMALIAN CELLS.

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The purpose of my research was to identify a specific genetic repair mechanism present in mammalian cells, and to transfer that mechanism to another mammalian cell in an attempt to reduce the permanent damage caused by a large dose of ionizing radiation.

To identify such a mechanism I obtained two frozen tissue cultures, rat dermal tissue[1], and rat aortal tissue[2]. These cell lines were then expanded and exposed to a cobalt-60 source[3] at various rad levels. The cells were counted with a hemocytometer and a dose which caused significant genetic damage to activate a repair mechanism that was present was calculated. Cell cultures were expanded and exposed to the calculated rad dose. Their enzymes and other proteins were then disassociated from the cell with ultrasound. These proteins were then transferred to damaged cells to determine if there was a repair mechanism present in the proteins that I had isolated.

The results indicate that a genetic repair mechanism does exist, and that this mechanism and it's effects can successfully be transferred to another cell. Such a response, similar to a heat-shock response has not been demonstrated previously in this fashion. Once this protein is isolated it could be used to make any mammalian organism 3-5 times more resistent to gentic damage caused by large doses of radiation.

[1] American Type Culture Collection # CRL 1213, FR [illegible], Germ-free fetal Rat), Passage [illegible], July, 1988

[2] American Type Culture Collection # CRL 1444, A7r5 (Smooth muscle aorta, [illegible] Rat), Passage [illegible], June, 1988

[3] Logan [illegible] Cancer Clinic. Canadian Nuclear, 4 years old, 114.89 rads/minute

#Second Award - U.S. Air Force
Third Award - General Motors ISEF/Microbiology

# MOLECULAR DETECTION OF RECOMBINANT PLASMIDS FROM SALMONELLA TYPHI IN ESCHERICHIA COLI

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Recombinant DNA techniques have facilitated the studies of bacterial virulence by allowing the production of genomic libraries of bacterial pathogens. These libraries are composed of bacteria containing recombinant plasmids which represent the whole bacterial chromosome. A cosmid library of Salmonella typhi was generated in Escherichia coli in order to study the capsular antigen of this pathogen. To detect the presence of chromosomal genes which code for the capsular antigen Vi, phage susceptibility tests, agglutinations, and agarose gel electrophoresis were used. The phage susceptibility screening assay was based on the fact that the capsular antigen Vi is the receptor for phage El. In this manner, it was expected that the Escherichia coli expressing the Salmonella typhi antigen would become susceptible to bacteriophage El. Out of 419 Escherichia coli containing the library tested, one strain was found susceptible to the phage. The expression of the Vi antigen in this strain was confirmed by agglutinations with specific antigens and also by detection of a plasmid through means of an agarose gel electrophoresis. This clone will be utilized in future studies on the genetics and expression of this virulent antigen.

#Fourth Award - General Motors ISEF/Microbiology

PHYSICS

APPLICATION OF EXPERIMENTAL VARIATIONS ENHANCING THE EFFICIENCY OF PHOTOVOLTAIC UNITS

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Due to rising energy costs and an ever decreasing supply of fossil fuels, the development of alternative energy resources is imperative. Solar power seems to be an ideal source of energy, however, it is not yet cost effective.

The purpose of this five year study was first to determine the effects of experimental variations on a photovoltaic unit's ability to produce electricity, and secondly to apply these discoveries and design a photovoltaic system that is more efficient than existing systems.

Research was done in each of the following areas:

1) angle of incidence of light rays striking the cell.
2) wavelengths of light.
3) fluctuating temperatures.
4) mediums of unit placement.

The proposed design includes such theories as immersing the solar cells in a liquid medium, use of a tracking system, Fresnel lenses, and cell array arrangement that includes both passive and active solar principles.

DETERMINING THE CONCENTRATION OF MISCIBLE LIQUIDS BY THE COEFFICIENT OF VOLUME EXPANSION METHOD

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The purpose of this investigation is to determine if there is a direct relationship in the coefficient of volume expansion of miscible liquids as the concentration varies. Data was obtained using a volumetric flask with a clear metric ruler taped to the neck of the flask. The flask was filled to the 100 milliliter mark and submerged in a zero degree water bath and allowed to reach equilibrium. It was then transferred to a water bath of a higher temperature. After the temperature of the solution reached equilibrium at the higher temperature, the change in volume was calculated. Then the coefficient of volume expansion was computed by dividing the change in volume by the original volume multiplied by the change in temperature. This procedure was repeated for the solutions of varied concentrations of the liquids ranging from 0% to 100% in increments of 10%. The analysis of data showed the direct relationship as hypothesized. Thus, one can find the concentration of an unknown solution of miscible liquids from measuring the coefficient of volume expansion and using either the equation or interpolating the graph.

The Electrolyte Level

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Purpose: to show that electronic innovations can be applied to all areas of life. Also to show that simple, yet practical, inventions are still being discovered; they're not all "taken". This machine serves the same basic purpose as the "bubble level" in construction, pool tables, etc. The main idea is to eventually develop a more accurate, more versitile, and more easily read level.

Procedure/Results: This machine actually works on the theory of electrolysis. Simply stated, an electrolyte is a fluid solution that conducts electricity. In this case, the electrolyte is a mixture of water, table salt, and corn oil. LED lights indicate which direction the surface is leaning and to what degree. Here's how it works: the horizontal tube is filled halfway with the electrolyte solution. The negative pole of a cell goes directly into the solution via a screw through the container. More screws, which act to complete a circuit between the lights and the liquid, are connected in series with each other and with the positive pole of the battery. Herein lies the key: the screws go through the tube and lie just above the water line when the surface is perfectly horizontal. However, when the surface is not straight, the water runs "downhill" and rises to touch the screw, thus completing the circuit! The steeper the incline the more circuits completed. Each light can be guaged to show how steep the angle.

Conclusions/Reflections: If the invention is improved upon, the gains made over the conventional "bubble level" could be great. More accuracy could be obtained, easier readings are possible, and an economical, marketable design could be helpful to many industries.

The Spectral Sensitivity of the Cat to Brief Stimuli

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Cats (4) were trained in a reaction time procedure to respond to luminance increments of various durations and spectral composition. Reaction time training required about 6 weeks and proved to be a very efficient psychophysical testing procedure characterized by 100% detection above threshold, and 200-300 responses in a thirty minute session of which 20 were threshold responses (misses).

Because the influence of stimulus duration is difficult to evaluate with other animal psychophysical techniques and figures prominently in the neurophysical analysis of the visual system, we explored its influence on the cat's visual sensitivity. All testing was conducted on a 30 cd/m^2 white background for a 10° increment. White increments of 25, 50, 100, 200, and 500 MSEC. indicated a critical duration of around 100 MSEC. Spectral sensitivity for 1000 and 50 MSEC. flashes both produced a two-peaked function with less sensitivity to the 50 MSEC. flashes. Reaction time at equivalent luminances around threshold was much faster and less variable for a 50 MSEC. flash compared to a 500 MSEC. flash. These data indicate that the cats' psychophysical critical duration is compatible with electrophysiological estimates; flash duration produces relatively little effect upon the shape of their spectral sensitivity function; and stimuli which produce relatively fast and brief ganglion cell discharge produce relatively fast and brief stimulus detectability.

THE EIGENMODES AND EIGENFREQUENCIES OF VARIOUS WOODS

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Ernest F.F. Chladni, who performed extensive studies on the vibrational qualities of plates, discovered a method of displaying the nodal and anti-nodal patterns of an oscillating plate. This method involves placing a powder over the plate and vibrating the plate at different frequencies. At certain frequencies, the eigenfrequencies, the powder is bounced to the nodal areas. The patterns formed are called eigenmodes. My project determines the eigenfrequencies and eigenmodes of various wooden plates and what affects them. To conduct this experiment, a function generator is attached to a stereo unit which in turn is attached to a speaker. The speaker is faced upward and each plate in succession is placed upon it. The plate is covered with a thin layer of salt and vibrated. The eigenfrequencies and eigenmodes are then recorded and photographed. The major causes of the differences in the patterns produced by the experimental plates include wood grain, wood type, and the method in which the wood was removed from the tree.

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* WATER LENSES AS OPTICAL ELEMENTS

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The use of water lenses instead of expensive glass lenses as elements in optical apparatuses was studied. It was shown that these can be used in constructing practical, easily assembled and low cost projection equipment with enough versatility as an aid in audio-visual classroom instruction particularly in rural communities. The result of the project is of particular significance for the improvement of the quality of educational instructions in Third World countries, where the use of indigenous materials and the need for self-reliance are indispensable concepts for national development.

*Third Award - American Association of Physics Teachers

Forced Mechanical Vibrations in a Test Rod

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If a system is excited by a sinusoidal force of frequency equal to its own natural frequency or one of its harmonics, then large resonant vibrations occur. This phenomena is known as resonance. A common problem in mechanics is the damping of resonant vibrations. The most universal solution is the application of external components such as shock absorbers or dynamic air cushions. This research dealt with changing an internal characteristic of a system in order to reduce its amplitude of resonant vibrations. Specifically, the relationship between the placement of mass within a test rod possessing sixteen degrees of freedom and its resultant vibrational spectrum over a frequency range of seventeen to twenty-six Hertz was determined. The results of this research show that as a greater percentage of a rod's mass is placed at its antinodes, shifts in resonant peak frequencies occur and the overall damping of the system proportionally increases.

#QUASI-CRYSTALS: STRUCTURE AND DIFFRACTION

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I investigate the diffraction patterns of one,two, and three-dimensional quasi-crystals. This investigation includes both theoretical and experimental aspects: I developed the techniques of producing photographically reduced diffraction gratings and optical quasi-crystals, and the corresponding laser induced diffraction patterns. I calculated the theoretical diffraction patterns for one and two-dimensional quasi-crystals, using my algebraic formula for the positions of atoms in a one-dimensional quasi-crystal, and models of two-dimensional quasi-crystals. I then compared these theoretical results with my experimentally determined diffraction patterns.

For the three-dimensional case, I calculate the diffraction patterns of models of layered decagonal quasi-crystals. I then compared these calculated diffraction patterns to the experimentally determined diffraction patterns of decagonal Al-Fe quasi-crystals measured by Fung et al (Phys. Rev. Lett. 56 2060 (1986)). I show that the structure of the Al-Fe decagonal quasi-crystal is a layered structure where the structure on each layer is based on the two-dimensional Penrose pentagon quasi-crystal pattern.

#First Award - General Motors ISEF/Physics
Scholarship - The University of Alabama in Huntsville
Second Award - American Association of Physics Teachers
Second Award - BDM Corporation
Honorable Mention - Eastman Kodak Company
Honorable Mention - Optical Society of America
Alternate to Scholarship - The Ohio State University

THE TURBOSAIL

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In this project I have studied the turbosail, an experimental propulsion device for ships. A turbosail consists of a vertical, hollow tube with a narrow slot running its length, and a fan mounted at the top. The symetrical sail is placed in a wind stream with the slot positioned at least 90 degrees from the leading edge of the sail. When the fan at the top of the sail draws air into the tube through the slot, the velocity of the air on that side of the sail increases. This increased air velocity causes a low pressure area near the slot. Higher air pressure on the opposite side of the sail creates a force in the direction of the low pressure area.

I have designed and built four different shaped turbosails, as well as a unique, pivoting wind tunnel on which to test them. I have tested each sail to determine which design produces the most force under controlled wind speeds. I have also tested each sail to establish a relationship between the velocity of air drawn through the slot and the amount of force produced.

The sail design I found to produce the most force was the one with a blunt extension on the leading edge of the basic cylindrical shape. I concluded that an increase in velocity of air drawn through the slot caused the sail to produce more force until the velocity approached 5½ meters per second. Beyond this point, an increase in velocity had no affect on the amount of force produced by the turbosail.

#First Award - U.S. Department of Energy

BOOMERANG AERODYNAMICS AND FLIGHT PATTERNS

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In this experiment, the flight characteristics of boomerangs were studied. It was hypothesized that the airfoil design of the boomerang arms is the principle factor that returns the boomerang to the thrower. Changing other elements of design, such as surface texture, center of mass, bend of the arms, and mass to surface area ratio may change the flight behavior of the boomerang, but such changes should not inhibit its return ability.

Ten identical boomerangs were made and fifteen standard of "control" throws were made of which only those throws which returned within a meter of the thrower were included in test results. Flight calculations for maximum height and maximum distance along the ground were made.

Modifications were then made, two boomerangs per variable, and experimentation repeated.

The results of the experiment were nearly as hypothesized with one exception. All modifications continued to allow the boomerangs to return while deviating from their original flight patterns except for changes in center of mass. Changes in surface texture by "dimpling" produced longer maximum distance and greater maximum heights. Increases in mass to surface area ratio created longer maximum distances also with shorter maximum height. Bend of the boomerang arms caused shorter maximum distance and greater maximum height, often adding a second loop.

Airfoil design of the boomerang arms is the essential characteristic necessary for their return. With further modifications, even changes in center of mass may have proved successful.

#First Award - U.S. Air Force
Third Award - General Motors ISEF/Physics
Third Award - International Aerospace Hall of Fame

THE MAGNETOHYDRODYNAMIC GENERATION OF ELECTRICITY USING THE ION DISTRIBUTIONS IN A PLASMA JET

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Hypothesis: Magnetohydrodynamic energy conversion principles can be applied to flame plasmas as well as gas plasmas in the generation of electricity. To demonstrate this, a flame plasma was first created using an oxygen-propane torch, the flame of which was "seeded" with a 3/25 solution of pottassium bicarbonate in water. The seed ions raised the temperature of the flame to over 4500F, at which point the flame became a partial plasma jet. The jet was passed through a uniform magnetic field of variable strength (800-1200 Gauss) perpendicularly to the lines of force. The Lorentz force caused the ionized particles to, in accordance with the right-hand rule, deflect from their original courses and create regions of like charge within the jet. Electrodes placed within these regions are charged to different potentials, thereby allowing a current to be drawn from them. The ammount of current drawn, discounting some measure to thermal flux created by the disintigration of the copper electrodes, is dependent upon both field strength and flame temperature, which can be predicted using the Saha Equation. This relationship can be used to determine an equation that can be used to predict the gross power output of any source of a flame plasma. The most practical use of this equation is in predicting the efficiency of "recycling" conventional rocket exhaust.

#First Award - U.S. Department of Energy
First Award - U.S. Navy
Fourth Award - General Motors ISEF/Physics

HOLOGRAPHIC INTERFEREOMETRY

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The purpose of this project is to show that simple techniques of holography may be used to pinpoint the areas of stress in engineering designs. In using basic holographic optical designs, two exposures were made of various objects: one, while the object was under stress; and another, while the object was relaxed. Due to the manipulation of the object and the complex physics of holography, dark interference lines appear on the reproduced hologram indicating the object underwent stress. In the successfully reproduced holograms, interference holograms, interference lines were produced in areas that were obvious to undergo stress. They also showed how much stress they underwent by the number of lines in the hologram. A very good percentage of the holograms supported or upheld the purpose of this project. Many trials resulted in excellent examples of working holographic interfereometry, as interference lines were found in very specific areas of the object seen in the reproduced hologram. Holographic Interferemetry has the potential to be applied in many fields of practical life today. It is possible that holograms could be used to find faults in designs of such things as circuit boards, computer chips, bridges and buildings. Very delicate or expensive designs could be tested for proper stress dispersion before they are put to use. As one can see, the practicality is important and indeed, the potential exists for a widespread form of testing designs without putting them through complete, conventional testing.

#Honorable Mention - Bureau of Reclamation/U.S. Department of the Interior

 # DOPPLER EFFECT IN RIPPLE TANK

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This project is to study the Doppler Effect by using a ripple tank. With water as propagation media, we can easily set up the apparatus to generate the source, to observe and to analyze.

We use a vibrating rod on a movable car to disturb the water in the tank to simulate a moving wave source. The "observer" consists of a pair of vertically seperated mirrors which are fixed on a movable car and a detector. We let a horizontal laser beam be reflected by the mirror which is under the tank into the water, and then reflected the beam again by the second mirror which is above the tank to the detector. They observe not the water wave itself but the laser beam which is modulated by the water wave motion. At last, in order to analyze the detected signal, we fed it to the Game I/O of a personal computer.

Detailed study has been aimed to find out the change of apparent period of the observer as a function of the relative position and velocities of both the observer and the source. It shows that the apparent period changes very rapidly only when the observer and the source is passing each other.

Based on our analysis, there is a very interesting aspect about this experiment. If the source and the observer are in different medium, wave will be refracted at the boundary between the medium. So the observer will hear the sound as if it is from a source situated at image site formed by refraction.

#Third Award - General Motors ISEF/Physics

"WASTE" FUELS-A COMPARATIVE STUDY

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Testing "Waste" Fuels for heat production and moisture content became important when our new school began burning these fuels. Samples were gathered from area firms and comparative tests performed.

5 mg. of each sample were tested for heat production in a self-made calorimeter. Each sample was burned to heat 5 ml. of water to 100°C. Times were recorded to reach 100°C and then 99°C. These tests were repeated and compared. Wood pellets heated fastest (2 minutes) while Hogwood was the slowest (8 minutes). The Hogwood, however, remained at 100°C for 6 minutes while the sawdust for only 3 minutes.

Moisture content was tested by heating 10 g. of each sample in a dehydrating oven for 24 hours. Mass was recorded before and after heating and the percentage of moisture was calculated. The moisture content of the "Fuels" were: sawdust (67% moisture), Hogwood (20%), woodchips (19.3%), sunflower hulls (19.3%), wood pellets (5.4%), garbage pellets (3.4%). The garbage and wood pellets contained the lowest percentages of moisture.

The wood pellets seem to be the most efficient fuel tested since it was low in moisture, reached 100°C the fastest and remained at 100°C for 6 minutes. This study opens many doors for further experimentation with "Waste" fuels. Perhaps "Waste" is a major source of energy for the future.

MEASUREMENT OF DRAG COEFFICIENTS OF AERODYNAMIC BODIES

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An inertial rotor was used to measure the drag (D) for a series of rectangular prismatic cylinders of varying size and profile. It was hypothesized that reasonable agreement between values of experimentally determined drag coefficients (CD) with known values for similar bodies would demonstrate the efficacy of this procedure as a possible alternative to a wind tunnel for measuring low velocity drag.

Moments of inertia were experimentally determined for the rotor components and test bodies with a torsional pendulum. Measurements of angular acceleration (AA) were determined from decay times for small angular displacements. These data were used to calculate torque (T) and subsequently, D for the test bodies. Regression functions were computed and used to predict AA, T and D for a range from 1 to 20 m/s.

It was found that CDs determined experimentally were in approximate agreement for short test bodies but increasingly overestimated longer bodies. The lack of discrimination in the calculated CDs for subtle differences in some of the shapes made the precision and accuracy of the measurements for decay time suspect.

It was concluded that a precision rotor of large radius with respect to the length of a test body could be used as an inexpensive alternative to a wind tunnel to measure D for low velocity flow.

#BROWNIAN MOTION: SIMULATION AND ANALYSIS

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In the absence of a medium, a particle undergoes free translation according to Newton's laws of motion. However, when the particle is placed in a medium, the molecules of the medium repeatedly deflect the particle, resulting in a random "Brownian" motion. This random energizing force is moderated by the frictional force of the medium. In addition, an external force such as a harmonic oscillator or electric field may be present. These forces and the particle's trajectory are related by a differential equation called the Langevin equation.

Simulation of Brownian motion by a Pascal computer program involves breaking the continuous Langevin equation into discrete timesteps on the scale of 10^{-14} seconds in length. During each timestep, one "hit" on the particle by a molecule from the surrounding medium is applied. The strength of these hits is chosen randomly from a Gaussian distribution. Then the particle's new velocity and position are calculated. For each trajectory, the values of a "correlation function" may be computed; this function indicates the extent to which a Brownian particle's velocity at a given time will affect its future trajectory. Laplace transformation of the continuous Langevin equation gives theoretical values for the correlation function. Comparing the calculated correlation to the expected theoretical correlation is one way of verifying the accuracy of the computer simulation.

By proper selection of the external forces, my algorithm may be used to simulate such diverse physical events as the interactions among ions in a salt solution and the kinetics of side chains on a protein. Since Brownian motion is typical of an entire class of problems in random differential equations, this microcomputer simulation has wide applications in mathematics, chemistry, and physics.

#Third Award - General Motors ISEF/Physics

WAVELENGTHS' DEPENDENCY OF THE BEND SENSITIVITY OF OPTICAL FIBERS

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Three multimode optical fibers that have different numerical apertures are necessary. Three different sizes of mandrels are also used. Different wavelengths are also necessary: neon laser, quartz halogen, mercury arc with an optical wedge using yellow and green.

The large fiber is mounted into a clamp, which is later adjusted to maximize the light input to the fiber. The other end of the fiber is placed into a light-tight chamber. The output of the fiber is read by a diode (APD), which is inside the chamber. Wrap the high fiber up to ten times around each mandrel. Record the power starting with zero wraps with the multimeter. Wrap the fiber once and record the output of light. Wrap again and record until the fiber has been wrapped ten times around each mandrel. Use all four types of light: red, yellow, green, and white. The experiment is continued by using the medium and low fibers.

While verifying the wavelengths of different colors of light, it changed the mode volume of the optical fiber. When more modes were present in the optical fiber, it took more mandrel wraps to reach an equilibrium. Since equilibrium is reached so much sooner, it is more efficient to use longer wavelengths of light. (Longer wavelengths are transmitted in a fewer number of modes than shorter wavelengths of light.)

Fibers that have higher numerical apertures are less affected by various mandrel wraps than those which have lower numberical apertures.

THERMAL ENERGY STORAGE, A FOUR YEAR STUDY

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The purpose of this project was to determine the optimum known phase change medium for use in storing solar energy for interior heating.

Using a model, impermeable solar panels containing $CaCl_2.6H_2O$ and $Na_2So_4.10H_2O$ were rotated. Results were recorded under actual varied weather conditions and compared to a controlled temperature base. The media tested were selected from numerous used in the industry with the goal of determining the greatest heat retention capability for passive application.

The model positioned the solar panel at an angle of 55° from horizontal and was placed with a south facing behind double glazed plexiglass. Results were recorded using glass bead thermistor probes attached to a computer which printed the temperature at 30 minute intervals over 20 days of testing. The model, selection of phase change components and computer program were all originated by experimenter.

This study concluded that of the wide range of components being tested in the approach to solar energy storage, Calcium Chloride Hexahydrate consistantly retained heat and dispensed heat longer than other media tested.

# ICE CHIPS (ALTERNATE SEMICONDUCTORS)

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The project was to determine if semiconductors could be constructed from alternate materials. Water was chosen because it, like the semiconductors currently used, does not conduct when pure and does conduct when impure. A small quantity of NaCl was dissolved into the water. An electrical current was then passed through the solution so the negative ions would congregate at the positive electrode and vice versa, thus forming P and N type solutions which were then frozen. A small quantity of each ice was joined together to form a diode. Since it was necessary to keep this ice diode cold, it was dubbed a "cryode." The NaCl cryode did exhibit diode action. This action was short lived, for the Cl ions would bond together into Cl_2 and then dissipate out of the ice. This eventually eliminated the N type charges, leaving solid P type materials which exhibited no diode action.

The next cryode consisted of ices made by the process above using an $NaNO_3$ solution instead of an NaCl solution. The diode action of the $NaNO_3$ cryode lasted 2½ weeks compared to the 2½ hour lifetime of the NaCl cryode, but its diode action wasn't as pronounced.

Final tests consisted of preparing cryodes at various concentrations of $NaNO_3$. The ratio of the reverse resistance of the cryode to its forward resistance was plotted versus the concentration of $NaNO_3$. The data fit a straight line showing the optimum $NaNO_3$ concentration for diode action to be saturation.

The cryode shows the realm of semiconductors to be much larger than expected, opening the door to exploring many new possibilities.

#Third Award - General Motors ISEF/Physics

# THE PHYSICS OF BLOWN SAND: A COMPUTER SIMULATION

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A computer simulation model was developed to study the effects of changing wind velocities on sand dune migration. The work of earlier researchers was used to model the rate of sand transport as a function of wind velocity. A series of experiments were conducted to determine the deposition distribution of the blown sand. The results of these experiments were incorporated into the simulator. The program was tested using a sine function as the starting sand dune distribution. The sand dune migration simulated in this test case appears reasonable based on the input data. A measured dune profile from the beach area at Seashore State Park in southeastern Virginia was also used as a starting sand dune distribution. Using the computer simulation model, the starting profile, and wind velocity data obtained from the Naval Weather Service, the migration of this dune field was determined for a three year time period. The results of these calculations were displayed as profile graphs. Based on these results, it appears likely that the entire dune field would become one large dune in the absence of vegetation.

#Alternate to Scholarship - The Ohio State University

MEASURING THE CHARGE OF AN ELECTRON: A NEW METHOD

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This project measures the charge of an electron by measuring the thermal and electrical conductivity of a metal bar and solving for the charge of an electron using the relation:

$$\frac{K}{\nu} = \frac{\pi^2}{3} \left(\frac{k}{e}\right)^2 T$$

K is the thermal conductivity; k is Boltzmanns constant; T is the absolute temperature; ν is the electrical conductivity; e is the charge of an electron.

The thermal conductivity (K) is calculated using the relation:

$$K = c\rho a = c\rho(A/tl)$$

K is the thermal conductivity; c is the specific heat; ρ is the density; a is the thermometric conductivity; A is the cross-section area; t is the time; l is the distance between the thermocouples.

A heat source is applied to one end of the bar. Two detectors measure the rate of heat transfer along the bar. The data are collected and plotted with an automated data collection system. The electrical conductivity can be measured with a Kelvin bridge.

The following are some typical results:

t	a	K	e	e accepted / e measured
134.31	$2.24*10^{-6}$	7.80	$1.09*10^{-19}$	1.47
128.87	$2.33*10^{-6}$	8.13	$1.07*10^{-19}$	1.50
145.57	$2.07*10^{-6}$	7.19	$1.14*10^{-19}$	1.41

For 24 trials, the average was 1.10 and the standard deviation was .04.

The results are in good agreement with the accepted value of $1.6*10^{-19}$ coulombs. It is believed that more accurate results will be obtained with improvements in the experiment.

# TRAPPING THE LIGHT FANTASTIC

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The purpose was to prove experimentally rather than mathematically that a hologram is simply a complex diffraction grating. By stripping the hologram to its bare essentials, a clear perspective was obtained for understanding the hologram, its implications in optics, and its applications in technology.

Three separate experiments were performed, and the results were compared to show the relationship between holography and diffraction. In the first experiment it was shown that a photographed pattern of ruled lines (a diffraction grating) causes redirection of a light beam according to the standard formula: $\sin \theta = \lambda/d$.

The second experiment was the creation of a hologram of the simplest possible object, a single beam of light. It was shown that the original beam could be recreated with the hologram. Microscopic examination of the hologram and measurement of relative beam angles revealed that the holographically recreated beam was just a diffracted beam.

Finally, a hologram of a scene was made. It was observed that the hologram redirected light from a laser beam to recreate the light originally coming from each point of the scene in the same way that the beam was recreated in the second experiment. Microscopoic examination of the hologram showed that it consisted of patterns similar to diffraction gratings but with more complex shapes.

The line of experimental reasoning developed in this work may be used to understand and apply computer generated holograms, degenerate four-wave mixing, and optical phase conjugation.

#First Award - Society of Photographic Scientists and Engineers

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THE PERFORMANCE OF FIBER OPTICS WHEN BENT

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Fiber optic cables used in industry and communications are often installed with bends in them. The goal of this experiment is to measure the relationship between the intensity of light transmission and the radius of bends in fiber optic cables.

I made measurements using two types of photodetectors, solar cells and photoelectric cells. Care was taken to control all variables in these experiments. A neon laser was used as a light source. The radius of the curvature was varied by use of cylinders ranging in size from 20 mm to 200 mm in diameter. The fiber was coiled around these cylinders and the intensity of the light transmissions were measured.

I found a relationship between the intensity of the light and the radius of curvature. When the radius of the coil was increased, the quality of the transmission was increased. I developed an equation to accurately predict the variations in light transmissions when one coil is bent around a cylinder. The intensity of the transmission in a 2 mm fiber optic cable is an exponential function of the radius of curvature. This function becomes asymptotic as the diameter of the curve approaches 200 mm.

The results of these experiments show a loss of light when there is a tight bend in a fiber optic cable. This loss can be calulated using the model which I have designed. It is important that care is taken when installing fiber optic cables to avoid loss in transmission intensity.

#Fourth Award - General Motors ISEF/Physics

NATURAL VIBRATIONAL MODES OF DIFFERENT RIGID MATERIALS.

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The objective of my science project was to answer the following question: How will composition, size, thickness, and boundary conditions of rigid materials effect their natural vibrational modes? I designed an apparatus that vibrated rigid aluminum, glass and plexiglass plates of different dimensions. When I produced a sound wave of a specific frequency, the plates would hit a resonant mode, and vibrate in distinct patterns, detected by talc migration to the nodal points. I also predicted the resonant frequencies mathematically. I found that glass had the highest modal frequencies, next aluminum and then plexiglass. By modal frequency, I mean the frequency necessary to produce standing waves on the plate surface. The thicker the plate, the greater the modal frequency; because more molecules had to vibrate in unison for resonance, activation frequency increased. Contrarily, as the plate's size increased, activation frequency decreased, for its additional area acted collectively to assist in total plate movement. The freer the edges of the plate, the lower the modal frequency; because the plate's ability to move collectively decreases when its edges are dampened, activation frequency increases. Practical applications of the experiment can be related to the science of acoustics, and engineering. For further research, I hope to study how vibration in structures can be minimized, and how sound may be amplified and controlled through resonance in materials.

#Second Award - General Motors ISEF/Physics

WHICH WOOD BURNS MOST EFFICIENTLY?

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Question: Which Wood Burns Most Efficiently?

Purpose: Many families in the United States are using wood as fuel to heat their homes. This project is designed to test several of the common types of wood for their efficiency as a source of energy.

Hypothesis: I think that hickory will burn most efficiently because through my research I found it is a high density wood and it has a high BTU rating.

Criteria: 1) Flame Temperature 2) Length of flame time 3) Difference in water temperature 4) Percent of wood burned.

Procedure: I burned a 2" x 2" x 1" block of 12 different kinds of wood and used their fires to heat 250ml of water. I collected statistics on flame temperature, length of time the flame was visible, the orignal weight of the wood, the weight of the ashes, the heated water temperature every minute for twenty minutes. I calculated the percent of wood that burned and the amount of change in the water temperature.

Conclusion: My experiment showed that sugar maple burned the most efficiently of the woods that I tested.

A STUDY OF A SOLAR CELL'S POWER WITH RESPECT TO INCIDENT LIGHT ANGLE

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A solar cell can produce maximum energy when sunlight reaches the surface of the solar cell perpendicularly. Since the sun is moving incessantly, a tracking device is necessary to keep the solar cell perpendicular to the sunlight. However, the device would be expensive and somewhat impractical. A solar cell thus could be fixed in a stationary position, forming an angle β with the ground.

This project was designed to provide a theoretical base to calculate the optimum angle β at which a fixed solar cell can produce maximum energy during a given time interval.

The solar cell was set at different angles to a steady light source. At each angle, the cell had a different power output. Both experimental results and geometrical analysis indicate a solar cell's power varies proportionally to the cosine of incident light angle. Next, a mathematical model was built to express how the power of a solar cell changes in relation to sunlight intensity, which depends on the distance sunlight travels in the atmosphere. Finally, a general formula was derived to calculate the angle β using integral calculus:

$$\beta = \operatorname{Arctan} \frac{\int_{t_1}^{t_2} e^{\frac{-\alpha h}{\sin(\omega t)}} \cos(\omega t)\, d(\omega t)}{\int_{t_1}^{t_2} e^{\frac{-\alpha h}{\sin(\omega t)}} \sin(\omega t)\, d(\omega t)}$$

The angle β determined in the above equation would assure the maximum energy that could be produced by a fixed solar cell during a given time interval.

#First Award - Midwest Research Institute through its division, the
Solar Energy Research Institute
Third Award - General Motors ISEF/Physics
Alternate - U.S. Department of Energy

THE PROPAGATION VELOCITY OF WEAK SHOCK WAVES PRODUCED BY SPARKS

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It has been demonstrated that electrical sparks can produce shock waves. The purpose of this experiment was to determine the relationship between the amount of energy used to make a shock wave from a spark and the shock's velocity.

An exploding wire spark source was used to create intense sparks (from discharge energies between 0.5 and 25 joules) in the air inside a 3/4" steel tube. A digital timer circuit determined the average velocity of the shocks at distances between 0.26 m and 1.00 m, by measuring the time the leading edges of the shock waves took to travel a known distance between two stationary microphones.

Both sonic and supersonic velocities were present in the data, indicating that sparks below a certain discharge energy produced sound waves, but not shock waves. The transition energies (the minimum energy required to make a shock wave) and the lines of best fit to the supersonic points were empirically derived from the two best data sets. Statistical analysis of the supersonic points in both data sets strongly indicates that the relationship between shock velocity and spark discharge energy appears linear over the domain of energies studied. In addition, there are suggestions in the data: a) that the shock waves are decelerating rapidly, attenuating into sound waves, and b) that the best fit lines to the supersonic points are actually very good linear approximations of some curvilinear function.

#COMPUTER MODEL OF THE Q1635+267 GRAVITATIONAL LENS SYSTEM

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When a distant quasar is lensed by a massive body magnified multiple images of the same quasar are produced. This phenomenon is called a gravitational lens system. A detailed computer simulation of the multiple-imaged quasar 1635+267 A,B has been designed in an attempt to predict the position of the unobserved lensing body. Using the designed simulation, for the quasar, image A and image B, it was determined that positions which best fit the available optical data were 1", 2.4" and 1.4", respectively, away from the lensing object. Using this model from the simulation, if the highly magnified image A was found to be 3.77" (arc seconds) away from B in position angle 176° and if B is in position angle 353°, the position of the lensing object was predicted to be 1" away from the quasar. Model-independent mathematical calculations indicate the mass(M) for the lensing object to be $M > 1.75 * 10^{12} h^{-1} M_{\odot}$.

This mathematically determined mass closely resembles a rich cluster of galaxies rather than a giant elliptical galaxy. A mass determination which coincides with the results obtained from the computer simulation of the same lensing object was proven. The fact that one of a cluster's inherent properties is not to contain great quantities of luminous matter further substantiates this research's findings because the deflector in the Q1635+267 lens system continues to remain observed.

#First Award - U.S. Army
Fourth Award - General Motors ISEF/Physics

WINDSURFING SAIL FOIL SHAPES

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There are four basic windsurfing sail shapes on the market today: flat, full batten, RAF and camber-induced. The foil shape refers to the shape of the cross-section of the sail. The manufacturers claim that each new shape is more powerful and easier to handle than those introduced earlier, and adjust the sail prices accordingly. The flat sail is the easiest and least expensive and the camber-induced sail the latest and most expensive. I wanted to find if the difference in the sails' performances are large enough to substantiate such price differences.

I first tested how much force each sail creates in the three main sailing positions by using models of the four sails in a large wind tunnel. Each shape was also tested for the amount of lift created. The results directly corresponded with manufacturers' claims; the flat sail created the least force and the camber-induced sail, the most.

I next tested how much turbulence each shape produces so that the relative ease of handling could be calculated. A smaller wind tunnel which injects smoke streams into the air was used along with wings of each shape. I tested each shape in two positions, and photographed the flow of air around the shapes in each position. Again, the results directly corresponded with manufacturers' claims.

Although there may have been some experimental error due to the small size of the models or inaccurate readings, I concluded that the different foil shapes did display substantial differences in both relative ease of handling and the amount of force produced.

#Third Award - Society of Photographic Scientists and Engineers
Honorable Mention - Eastman Kodak Company

MEASURING BROWNIAN MOVEMENT: AN EMPIRICAL STUDY

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Brownian movement is the irregular motion of nonliving microscopic particles caused by thermal motion of the molecules of the material in which the particles are placed. The particles will randomly collide with the molecules of the substance which will give energy and momentum to the particles. What effect will temperature change have on particle collisions? Can the movement be measured using current technology? Will changing the solution in which the particles are observed make a difference?

In my research project I have used modern electronic equipment and have found an accurate method of measuring thermal movement of microscopic particles. Results suggest that velocity changes exponentially with temperature change and that changing the solution affects the rate of movement. This information may be beneficial to environmentalists, physicians, manufacturers and other researchers who are interested in the extent of diffusion and osmosis of chemical products.

Rotation Stabilizes Cellular Convection: A New Understanding of Solar Granulation

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Convection is a driving force behind the transfer of gaseous fluid materials within the earth's atmosphere and the sun. Often such convection takes place through the formation of cells which one can see even on the surface of a cup of coffee. With the fluid system first placed on a stationary platform, cells result from an interplay between gravitational, buoyancy, and surface tension forces. The stability of the cells is found to depend crucially upon certain parameters of the fluid -- i.e. the depth (h), the kinematic viscosity (ν), the thermal diffusivity (k), the coefficient of thermal expansion (ϵ), the temperature gradient (ΔT) and the acceleration due to gravity (g) -- via the dimensionless Raleigh number $Ra = [g\epsilon(\Delta T)h^4]/(\nu k)$. A critical value for Ra of about 1100 is determined in the present experiments, below which the cells do not form and above which they do. Once Ra far exceeds the critical value by about one order of magnitude, however, the stability progressively disappears.

Uniform rotation of the platform holding the fluid container introduces two new forces: the centripetal force in the inertial frame and the coriolis force in the non-inertial frame. Both in turn are found to greatly increase the stability of the cellular convection. As the angular speed Ω increases, the critical value of Ra increases as well, thereby the stability of the convective cells is achieved for values of Ra far exceeding the value of 1100. This observation that rotation greatly increases the stability of cellular convection can be used to explain why large-scale convective systems such as those found on the sun are relatively stable.

#First Award - American Association of Physics Teachers
First Award - American Meteorological Society
First Award - General Motors ISEF/Physics
Scholarship - The University of Alabama in Huntsville
Honorable Mention - National Aeronautics and Space Administration
London International Youth Science Fortnight Trip - U.S. Navy
Glenn T. Seaborg Nobel Prize Visit Award

FACTORS IN THE ADAPTABILITY OF METALS FOR SPACECRAFTS

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The probing of man and machine into space has created a need for spacecrafts that can withstand the extreme high and low temperatures of space flight. The purpose of this project is to determine if high carbon spring steel is a suitable space manufacturing material.

A coil of spring steel was selected as the medium to be tested. Premeasurements of its physical dimensions and length when pulled by a 100 g weight were taken. Two parallel marks were made lengthwise on the top of the coil. It was then placed in an apparatus for four(4)hrs. to simultaneously subject half of it to 617°F and the other half to -109.3°F. After returning it to room temperature, post-measurements were taken. The marks of the heated side showed that each ring had rotated approximately 5 mm. This caused a 1.8 mm reduction in diameter, a 1.4 mm increase in length along the top of the coil, and a 3.6 cm increase in length when restretched with the weight. The cooled side showed no changes in shape.

After further study it was concluded that the heated side changed its dimensions due to the annealing process which relieved the stresses applied during manufacturing. An uneven release of these stresses induced a torque on the coil causing the rotation and the change in size. The change in stretch length resulted from the loss of the shape-retaining forces. It was concluded that high carbon spring steel is not a suitable space manufacturing material. Extreme heat, such as is encountered in space flight, would cause permanent physical dimension changes in the metal.

#EXPERIMENTS IN ACCELERATOR DYNAMICS

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The objective of this project was to complete the construction and operation of an eight inch magnetic resonance particle accelerator commonly known as a cyclotron. After much modification and testing as described in the following paragraphs, the cyclotron was successfully operated. It produced accelerated singly ionized hydrogen molecules.

To facilitate the successful operation of the cyclotron, several modifications to the original design had to be made. The first of these modifications was the rewrapping of the electromagnet coils to produce a stronger, more uniform magnetic field. The vacuum box also had to be altered so that it could be placed between the poles of the magnet more easily and would have a better vacuum seal. A 3/4 inch pipe was installed in the vacuum outlet to improve pumping speed. A mechanical vacuum pump with a higher optimum pressure than the pump previously used and a three stage diffusion pump were used to produce a better vacuum. Several methods of sealing were tried before a method of O ring sealing was found to produce the best seal.

A control panel to regulate and measure the current flowing to the electromagnet coils and ionizer was built. A Hall probe for more accurate magnetic field readings and an electrometer for more sensitive beam detection were also constructed. A thermocouple gauge and window were installed in the vacuum box. The ionized hydrogen emitted a blue glow which could be focused into a column by adjusting the magnetic field.

#Scholarship - The Ohio State University
First Award - Vacuum Technology Division of the American Vacuum Society
Fourth Award - General Motors ISEF/Physics

#IDENTIFICATION OF HIGH EXPLOSIVES BY FUSION MICROSCOPY

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The identification of high explosives has presently been through highly complex methods such as Liquid Chromatography, Gas Chromatography, Mass Spectrometry and Infra Red Analysis. This is an attempt to identify high explosives utilizing much simpler microscopic techniques of fusion and melting point. Twelve high explosives were selected for this study. These compounds were chosen to exhibit a wide variety of both commercial and military high explosives.

A number of scientific papers have appeared in the literature utilizing fusion methods for the identification of various groups of organic compounds including steroids and synthetic polymers. This is the first time this technique has been used to identify high explosives. Fusion microscopy is simply heating a substance to its melting point, slowly allowing the substance to recrystallize, and studying the optical characteristics with a polarizing microscope.

Microscopic fusion analysis should be an ideal method for high explosives since they have relatively low melting points and thus should have low temperatures of recrystallization. This property is essential to enable a slow even recrystallization of a compound at room temperature.

It was concluded that one can easily identify high explosives by examining their recrystallized structures. An identification key was constructed along with graphs to depict conclusions derived from the specific chemical groups of each explosive.

#Second Award - U.S. Air Force
Honorable Mention - American Chemical Society

Sir Isaac Newton and the Rising Fast Ball

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Baseball players, fans, and even physicists have long debated whether of not a spinning fastball will rise on its journey from the pitcher to the batter. This debate formed the basis for this investigation. The investigation is to determine: A) Rate of rotation of the baseball; B) Speed of the baseball; C) Whether or not a spinning fastball rises. A number of failed attempts were made before finding the saught after factor.

To determine the rate of spin on the baseball, strobescopic photography was successfully used. The next challenge was to find the speed. By using a laser and a modified photogate attached to an Apple computer, the initial velocity of the ball could be found. The Vernier Timing Program along with the knowledge of the baseball's diameter were also needed. The initial velocity was then calculated using the formula rate equals the distance divided by the time. To determine whether or not the ball would rise due to backspin, the distance traveled was measured and compared to the distance determined by the kinematic formulas. The ball with backspin traveled further indicating a rise of at least a slower rate of drop during the flight.

#PROJECTED SPECKLE METROLOGY COMBINED WITH REMOTE FIBER OPTIC IMAGING FOR THE DETECTION OF SURFACE MOTION IN POLYMERS

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The purpose of this project is to determine if projected speckle metrology can be used efficiently and effectively in combination with fiber optics for the determination of surface motion in polymers.

Speckles are a type of light noise that exist as areas where light is absent in a beam of coherent light. Speckle patterns, a random arrangement of speckles, are produced when light of adequate coherence is dispersed by a surface that creates random optical path undulations. Speckle patterns are excellent for use in the determination of surface motion, because when an imaged surface is deformed, the speckles are displaced. These displacements can be measured by digital correlation. In experimentation polymer disks were imaged with speckle patterns. These disks were then uniformally stressed at their centers. The deformations occuring in each disk were digitally recorded with a photoelectronic numerical correlation system consisting of a vidicon camera, digitizer, and mini-computers. The relative amount of surface deformation was acquired by correlating the amount of displacement occuring on each disk during different magnitudes of load.

#Fourth Award - General Motors ISEF/Physics
Alternate to Scholarship - The University of Alabama in Huntsville

ATTEMPTS TO CONSTRUCT AND PERFECT A PSYCHOACOUSTIC IMAGERY RECORDING SYSTEM

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Is it possible to construct and perfect an audio recording system that makes recordings so realistic that the direction of sound origin of the recording source can be detected?

It is hypothesized that such a recording system can be constructed and perfected. The system consists of a cassette recording deck, an image enhancer device, and a dummy head. The microphones are placed in the ears of the dummy head to simulate human hearing.

After the construction of the imagery recording system, the researcher conducts three experiments using thirty subjects. In the first experiment, the subjects are tested determining their ability to detect direction of sound origin in a live environment. In the second experiment, the subjects are tested using a conventional recording of the sound source. In the final experiment, the subjects are tested using a recording of the sound source made with the psychoacoustic imagery recording system.

Finally, the researcher compares the two recording systems to the live source and to each other to show how much more realistic the imagery recording is than the conventional recording.

The concluding data analysis indicates that the psychoacoustic imagery recording system improves the ability to detect direction of sound origin and produces a more realistic recording.

#SONIC COMPASS FOR THE BLIND
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The Sonic Compass was invented to help blind people re-orient themselves when they become confused about direction. The device is contained in a 3"X6" box, is battery operated, and cost about $17.00 to produce. It contains an ordinary magnetic compass which has a hole in the north end of the needle. The direction the needle is pointing is detected by a light-emitting diode (LED) and a phototransistor (PT). When the compass needle breaks the light path between the LED and the PT, the electrical resistance in the PT increases. The PT is in series with another resistor and hence acts as a variable voltage divider resistor. The divided voltage is used as a signal to a voltage comparator integrated circuit. By adjusting the reference voltage to the comparator IC, the circuit can tell the difference between the north end of the needle (which has the hole, blocks only part of the light and causes a small change in signal voltage) and the solid south end of the needle (which blocks all the light and causes a large change in the signal voltage). The IC sends a current to a buzzer which beeps when the device is pointed north.

#Honorable Mention - American Optometric Association and the Auxiliary to the American Optometric Association
Alternate to Scholarship - The Ohio State University

Determining The Rate of Fluid Flow In A Venturi Tube
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A Venturi is a device by means of which the velocity of a fluid can be measured. The operation of the Venturi is based upon Bernoulli's Principle. Basically Bernoulli's Principle states that where there is an increase in velocity, in a fluid, there will be a decrease in pressure. The velocity at the constriction increases because less volume per unit time can pass through it. In order for the same amount of fluid to leave the Venturi that has entered it, there must be an increase in velocity. This increase in velocity will cause a decrease in pressure at the constriction.

The purpose of this investigation is to determine the rate at which a fluid flows.

A U tube manometer is connected between the mouth and throat of the Venturi to measure the pressures. The change in pressure is measured and applied to the appropriate formula, from which the velocity at the mouth can be determined. The values from this were only theoretical. To find the actual rate, I measured the time it took the pump ten thousand cm^3 of water. I found that the actual rate varied from the theoretical rate by approximately ten to fifteen cm^3/sec.

There are many uses for the accumulated data of the Venturi tube. The information is very helpful in determining the efficiency of water flow in city water systems.

QUANTUM PHYSICS - GAMMA RAY - DISCOVERY: JONIEL EFFECT

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The objective of this research project was to determine changes in interactions of gamma radiation over an energy range of 88 to 1332 Kev. Rigorous spectral analysis and theoretical determinations of gamma interactions (computer aided) resulted in several conclusions concerning photoelectric interaction and compton scattering. The procedure to attain spectrums or specific energy measurements involved: placement of materials and source, calibration of scintillation detector, setting discriminator units for desired energies, and initiating counter and timer. Conclusions formed concerning gamma interactions covered: 1) energy regions in which the photoelectric effect and compton effect are dominant, 2) angular distribution and transmission of gamma through materials, 3) the existence of characteristic peaks for gamma energies.

Extensive analysis of gamma interactions, led to my discovery of an interesting and unique effect: a periodic change in a specific ratio as a function of the material thickness and electron density. This discovered effect is called the "JONIEL EFFECT" and the ratio, the "JONIEL RATIO".

Subsequent analysis of the JONIEL EFFECT/RATIO led to the development of 3 important applications involving the determination of a materials: 1) thickness, 2) electron density, 3) composition repeatability in manufacturing (SPC). Additionally, the measurements are non-destructive, possible for a wide range of materials and thicknesses, and can achieve accuracy desired. Thus, significant applications are possible by applying the principle of the JONIEL EFFECT in industry and laboratories.

HOLOGRAPHIC INTERFEROMETRY: A NEW APPROACH TO FINDING THE STRUCTURE AND FLUX DENSITY OF MAGNETIC FIELDS.

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3111 N. Kinser Pike, Bloomington, IN 47401

The purpose of this experiment is to establish holographic interferometry as an alternate method of mapping complex magnetic fields. In this experiment magnetic field density was calculated by measuring the amount of deformation caused by the magnetic field on magnetically susceptible material. The deformation was related to the field density using Young's Modulus. In order to measure the amount of deformation or flexure caused by the field a system was needed that could measure accurately without disrupting the magnetic field. These conditions necessitated that the system be passive and/or remote. For these reasons, the system chosen was holographic interferometry. Construction of a vibration isolation system necessary for holography was followed by testing with the Michelson Interferometer. Double-exposure interference holograms were made by exposing the first hologram and then subjecting the bar to a magnetic field. A second hologram was then made. Any movements of the metal were recorded as fringe lines. Each line represents approximately 300 nanometers of movement. The magnetic field density, amount of movement, and the dimensions of the bar were substituted into the equation $M = mgl^3/4sa^3b$. From this equation Young's Modulus was calculated with 1.1% error. Although the accuracy of holographic interferometry was not as severely tested as originally planned due to the gross measurements of magnetic field density and thickness of the bar, it does seem to show promise as a method of measuring magnetic field density.

#Second Award - General Motors ISEF/Physics

# RADIO SOURCES IN THE THEORETICAL HYDROGEN SPECTRUM

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PURPOSE: Construct an instrument capable of detecting and confirming Celestial Hydrogen Emission Spectra.
PROCEDURE: Refine existing 49 foot radio telescope. Acquire signals as function of time. freq.. ant. elevation. Resolve data. Compare data with known optical sources. Change frequency. Re-run. reduce data. compare.
MATERIALS: 1) Existing Radio Telescope installation. 2) Test instruments. A/D Converter. Computer 3) Op-amps. support components 4) Microwave modular components 5) Resistors. capacitors. dip switches. precision potentiometers.
DATA: Components and system tests / calibrations. Transit of the Sun. Sagittarius. man-made sources on and off the 1420 - 1424 mhz. hydrogen spectrum.
CONCLUSION: There was 1420 - 1424 mhz. "brightening" from Sun. Sagittarius. Off frequency = less or none. adequately described by Max Planck in 1900 in the formula. $\Delta E = hv$ where v = frequency of oscillation. h is Planck's constant 6.626 X 10^{-24} joule-seconds and E = the ground state transition energy of Hydrogen.
APPLICATION: Hydrogen observation allows detection of non-visible matter. extended solar atmosphere. galactic center. Application in reception of very weak microwave signals. communications. space vehicle telemetry. Signal integration is "signal gathering" like photo film gathers light over time. Long distance. qualitative. chemical analysis. Universality of Physical law. ECM detection. "The total amount of energy from outside the solar system ever received by all the radio telescopes on the planet Earth is less than the energy of a single snowflake striking the ground." - Carl Sagan.

#Second Award - Patent and Trademark Office/U.S. Department of Commerce/
Patent and Trademark Office Society
Fourth Award - General Motors ISEF/Physics
Alternate to Scholarship - The University of Alabama in Huntsville

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TESTING THE TENSILE STRENGTH OF HUMAN HAIR: PHASE II

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Photoelectron observation proved that there was extensive damage to samples of treated hair. It was hypothesized that the damage was caused by abuse of grooming aids. It was unclear at this point just how the problems set in.

Samples of processed hair did have much more damage than samples of virgin hair, so averages of tensile strength were taken of various samples of virgin hair in order to achieve a standard reference sample for comparison with averages of tensile strength taken from samples of processed hair. Tensile strength testing was done by employing a fabricated apparatus constructed with adding machine tape and a strip of elastic. Treated hairs were individually inserted through a reinforced hole in the unattached end of the elastic, and pulled to par. At the breaking point, a mark was placed on the adding machine tape. 17 hairs from various samples were tested this way. A millimeter measurement was taken between the breaking points and the untensed point of the elastic, and converted to grams of weight. The data was combined and graphed to achieve a standard curve. The average tensile strength of each group was acnieved by approximating the slope and intercept.

Further testing is necessary to draw accurate conclusions about the effects of grooming aids on the hair.

MONOFREQUENCY WAVEFRONT INTERFERENCE

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By superimposing identical coherent wave patterns, various interference designs can be created. Dr. Dennis Gabor first proposed utilizing this phenomenon to photograph objects and then reconstruct the images by projecting light through the photographic plate. This project employs a Class II Metrologic helium-neon laser with a maximum output of one milliwatt to test variations on the basic Michelson interferometer configuration. Secondly, the effects of introducing the variable of refracted light into the interferometer system are evaluated. Laser light is ideal for experimentation of this type, as it allows for more precise measurement. Monofrequency light tendencies around opaque objects are easily predicted using Huygen's wave theories.

ZOOLOGY

A CROSS-SPECIES STUDY OF ANTI-NERVE ANTIBODIES

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Certain monoclonal antibodies raised against rat nerve appear to recognize like tissue in other animals. Are these antibodies universal or do they only recognize tissues in animals evolutionally close to the rat? In this project it was hypothesized that the antibodies would recognize (or stain) tissue in animals radically different than the rat but the staining would be brighter in animals' brains nearer to that of the rat. Rat, fish, frog, lobster and worm brains were stained with antibodies in a procedure called immunohistochemistry and then studied under a fluorescence microscope. By observing the produced staining pattern it could be determined which antibodies were universal. Four antibodies: 16/41, 8/156, 2/2 and 9/175 were found to stain the brains of four or more animals with an equally bright pattern. The majority of the antibodies stained all brains but stained the fish and frog brains more brightly. I conclude that not all antibodies react in the same way - some may recognize a universal antigen and others may not be able to do so. Those antibodies which stained all five of the brains must recognize a universal antigen important to the development or lives of all animals, for example the nerve particles controlling balance or movement. This experiment shows some similar characteristics in the vastly different nervous systems of lower animals.

EFFECTS OF ENVIRONMENTAL ALUMINUM EXPOSURE ON THE SEXUALLY DIMORPHIC BEHAVIOR OF MAL. *GAMBUSIA AFFINIS AFFINIS*

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Because aluminum is the most abundant metallic element in the earth's crust, and because of the widespread occurrence of acid precipitation which mobilizes aluminum from the edaphic into the aquatic environment, it has been the purpose of this three-year study to determine the possible effects low-levels of naturally occurring environmental aluminum may be having in the aquatic ecosystem. Specifically, this study was designed to elucidate the effects of low levels of environmental aluminum on the mosquitofish, *Gambusia affinis affinis*, with emphasis on reproductive behavior and isolating sexually dimorphic male behavior.

During this phase of research, several *Gambusia* were continually exposed to low levels of aluminum (1 ppm) in a static assay set up according to the ASTM standards, while others were established as positive and negative controls. Three separate tests were conducted, each five weeks in duration, for a total of 15 complete weeks of observation. Through videotape techniques, the reproductive behavior was categorized, quantified, and compared to published studies on *Gambusia* behavior.

Because those *Gambusia* exposed to low levels of environmental aluminum lacked normal reproductive response, one can hypothesize that some alterations are occurring in the endocrine and/or neuroendocrine control. Ultimately, this study has found that aluminum-exposed males significantly deviated from established behavior patterns, which had a direct affect upon female behavior, and resulted in limited reproductive activity.

From this preliminary research, it is clear that differences in the reproductive behavior of *Gambusia affinis affinis* are directly associated to treatment in low aluminum levels, and is especially important when considering the growing acidity of our environment which results in increased levels of mobilized aluminum.

#First Award - U. S. Army
First Award - U. S. Navy
Second Award - General Motors ISEF/Zoology
Alternate - U. S. Department of Energy

DETECTION OF MAGNETIC SENSITIVITY IN A SELECTION OF INVERTEBRATE ORGANISMS

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In this project, the visible behavioristic reaction of 14 selected invertebrates to a controled static and pulsed magnetic field was analysed. Carpenter ants, harvester ants, flour beetles, crickets, earthworms, ladybugs, cutworms, millipedes, cockroaches, fruit flies, gnats, houseflies, squash bugs, and terrestrial isopods were each subjected to a pulsed magnetic field to assess their reaction. Carpenter ants were subjected to a static field also, to determine the effects of magnetic fields on colonizing behavior.

Of these invertebrates, carpenter ants, earthworms, cutworms, fruit flies, gnats, and houseflies reacted visibly whereas the others did not. The creatures that reacted are either colonial or migratory. Other research suggests reactions to magnetic fields like those used here could indicate a presence of magnetite.

EFFECTS OF TEMPERATURE ON RESPIRATION AND VENTILATION OF *ACHETA DOMESTICA*

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This study was conducted to determine the effects of temperature on the rate of oxygen consumption and on the severity of ventilations of *Acheta domestica*, the house cricket. Twenty-four crickets were tested, 10 at 21°C, 10 at 30°C, and 4 at 40°C. The crickets were monitored in a volumetric respirometer which was placed in a water bath and was capable of measuring microliters. The crickets were monitored every thirty seconds for an hour or until the limit of the measuring instrument on the respirometer was reached. The crickets had an average rate of oxygen consumption of 0.00900, 0.0248 and .0804 milliliters per minute per gram of live weight at 21, 30 and 40°C, respectively. Ventilations, or intermittent breathing, became much more apparent, severe and dynamic with each increase in temperature. Because of the extremely fast rate of respiration at 30 and 40°C, the effect of temperature on the frequency of ventilations could not be determined.

#Fourth Award - General Motors ISEF/Zoology

GENETIC DOMINANCE THROUGH HEREDITY IN *DROSOPHILA*

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Genetics is the study of mechanisms by which characteristics of parent organisms are passed on to their offspring. In this investigation, winged and wingless Drosophila were cross-mated to study the patterns of dominant and recessive genes through inheritance. From this cross, it was thought that the F_1 (first filial) generation would all be winged. The F_1 generation flies were then mated among themselves. Due to research and the study of probability, it was thought that their offspring - the F_2 generation - would be about 3/4 winged and about 1/4 wingless. The results supported this hypothesis and thus it was concluded that although recessive genes are not always visible when crossed with dominant genes, they are carried and do appear eventually in future generations.

THE EFFECTS OF LIGHTING ON SEA URCHINS

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The sea urchin, *Arabacia punctulata*, is abundant on the granite boulders of the jetty system along the Brazos-Santiago Pass near South Padre Island, Texas. It is easily collected on the jetty structures.

The aim of this research is to determine the effects of different lighting situations, such as white light vs. total darkness, ultraviolet vs. total darkness, red light vs. white light, and red light vs. total darkness.

From an analysis of these experiments one can conclude that sea urchins prefer shaded areas. The rate of movement toward the shaded areas is not affected by differences in lighting situations when sea urchins are subjected to white light vs. total darkness, or red light vs. white light. A significant increase in the rate of movement exists between ultraviolet vs. total darkness, and red vs. total darkness situations. Additional work indicates that bright light also induces the shedding of viable gonadal secretions.

#INVESTIGATING THE PROS AND CONS-PERCA P. FLAVESCENS VS. CAMBARUS C. VIRILIS-A 3 YEAR STUDY OF THE INTAKE OF RADIOACTIVE ISOTOPES

NICOLE GAUDET
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The purpose of my project was to expose 5 fish and crawfish to 32P and 125I, using 1 control specie for each isotope. After placing experimental models in 32P and 125I they were sacrificed with ethyl ether and dissected. I took 3 tests on the following organs of each specie and averaged the amount of radiation in each organ. These were the results:

32P	FISH			CRAWFISH			
Heart	9.57	CPM/31.9	DPM	409	CPM/	1363	DPM
Gills	7.46	CPM/24.9	DPM	1178	CPM/	3927	DPM
Muscle	2.37	CPM/7.90	DPM	42	CPM/	140	DPM
Intestines	9.04	CPM/30.1	DPM	3511	CPM/	11703	DPM
Stomach	7.43	CPM/24.8	DPM	435	CPM/	1450	DPM
Liver	3.80	CPM/12.6	DPM	304	CPM/	1013	DPM
125I							
Heart	1368	CPM/1679	DPM	86.8	CPM/	107	DPM
Gills	1686	CPM/2069	DPM	16606	CPM/	20383	DPM
Muscle	347	CPM/ 426	DPM	235	CPM/	288	DPM
Intestines	165	CPM/ 202	DPM	241	CPM/	296	DPM
Stomach	2713	CPM/3331	DPM	4797	CPM/	5888	DPM
Liver	899	CPM/1103	DPM	23.8	CPM/	29.2	DPM

Fish and crawfish were obtained from a fresh-water environment. A soil and water analysis was taken for radioactive phosphorus and iodine. Knowing that the level of radiation was in such small amounts(probably PPB units) it was undetectable. My results can be explained due to enzymatic reaction which takes place in each organ. Co-enzyme and enzyme reaction is why the muscle absorbed the least radiation. This is also due to the filtering process done throuch the main organs. This is due to the physiological adaptation of the species.

#Honorable Mention - National Aeronautics and Space Administration

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CHROMOSOMICAL AND STATISTICAL STUDY OF OVULEN 28 AND DELFEN AS MUTAGENIC AGENTS

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The principal purpose of this investigation is to investigate if the spermicide "Delfen" and the anticonceptive "Ovulen 28" causes mutations in the chromosomes of D.melanogaster.

The methods and techniques used were: The preparation of instant culture media (Winchester); the preparation of chromosome's slides squashes; the results were analized using a statistical study.

The results of the chromosomical study with Ovulen 28 in the F$_1$, revealed as follows: bent mutation is in the chromosome 4, gene 1.4; aristaless mutation is in the chromosome 2, gene 0.0 (locus). The results with the spermicide Delfen showed: vestigial mutation in chromosome 2, gene .67.

In the F$_2$, curved (wing mutation) was observed. This mutation is in the chromosome 2, gene 77.3. Black body mutation was observed in F$_3$, in the chromosome 2, gene 48.5.

The statistical study revealed: that the spermicide and the anticonceptive affects the population density and the reproductive cycle of the fruit fly.

Finally it was concluded that the spermicide "Delfen" and the anticonceptive "Ovulen 28" affects the reproductive cycle and the population density, and causes mutations in the phenotype and the genotype of the fly.

A SECOND YEAR STUDY RECOGNIZING THE GENETIC INDIVIDUALITIES IN RATTUS NORVEGICUS USING OLFACTORY AND URINALYSIS

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This study was conducted to determine whether or not it is possible to detect a male/female attraction in Rattus norvegicus (rats) based on the scent of their urine. Also, to see if it is possible to determine the components of the urine and what the attacting agent may be. I believe it is possible to determine a male/female attraction in rats based on the scent of their urine. I think the attraction will be more prevalent in male to female situations than in female to male. I think it will be possible to determine the components of urine. However, I think there will be difficulty determining a main attracting agent.

Urine was collected from 4 rats of different families. 12 sexually mature rats were tested with the urine in a Y-maze. The 6 males were tested under 2 conditions: female urine vs. none, female vs. male and the 6 females were tested under 2 similar conditions: male urine vs. none, male vs. female. The urine was alternated from one side to the other with each test. Urine samples collected were tested with a CHEMSTRIP to determine the amount of certain components in the urine. A spectrophotometer was used to determine the components which were most prevalent in the urine.

It was found that of the male rats tested they went to the female urine 75% of the time against no urine, and 67% of the time against male. Of the females tested in male vs. none situation, they went to the male urine 78% of the time and 72% in the male vs. female. It was also found through urinalysis that urine from the females had more protein than that of the males which had more blood. All the urine had pH of 5 or 6 and the spectrophotometer did not prove very successful, although some registered more than others, 1 main attracting agent wasn't found.

AN IN-DEPTH STUDY OF THE BREEDING HABITS OF SOCIETY FINCHES

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This is a study of Society Finches. Society Finches do not exist in the wild state. They are fertile hybrids and the oldest domesticated species of cage bird. They came from China and Japan around 1700 but their original parentage is not known. Society Finches have well-developed maternal instincts and make excellent foster parents.

Five breeding pairs of Society Finches were observed during their nesting season. Eight observational experiments were carried out which included investigating Society Finches fostering ability:

a) to establish the most suitable diet
b) to determine the most suitable breeding cage and nest
c) to prevent dead-in-shell chicks
d) to prevent egg binding in hen Society Finches
e) to investigate the fertility of hybrids bred from Society Finches x Straited Finch pairings
f) to establish food intake pattern among Society Finches
g) to establish a growth pattern among Society Finches, and,
h) to investigate the fertility of hybrids bred from Black Headed Nun x Spice Bird x Society Finch pairings and to study the fertility of hybrids bred from the aforementioned hybrids paired to Society Finches.

It was discovered that the average clutch of eggs is five, and the average incubation period is fourteen days. It was also discovered that the newly hatched Society Finch is not fed for the first 24 hours of its life. It was found that hybrids bred from Society Finches x Straited Finch pairings are fertile. It was also found that egg binding can be prevented in most cases, and, in some cases, dead-in-shell chicks can be prevented.

THE EFFECTS OF HORMONES ON SECONDARY SEX CHARACTERISTICS

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OBJECTIVE To experimentally determine the effects of added amounts of testosterone in healthy juvenile *Gallus Dominique*.

HYPOTHESIS I think that when the amount of testosterone in juvenile *Gallus Dominique* (cockerels) is increased to levels above natural amounts, they will demonstrate a greater weight gain and an acceleration in the development of secondary sex characteristics.

PROCEDURE To determine the effects of increased amounts of testosterone in cockerels, I began my study by injecting three cockerels with .1cc of testosterone solution, three cockerels with .1cc of sesame oil and one cockerel had no injections. The beginning weight of each cockerel was recorded. At the beginning of the second week each of the doses were increased to .2cc. Injections, weights, and observations were recorded on a daily basis for 2 weeks.

CONCLUSION In the course of the experiment, I observed that the testosterone injected cockerels matured at a rate much above that of the control groups. The control groups having received no added testosterone, also showed marked weight gains but at a rate clearly less than that of the experimental group. In addition to increased weight gains, secondary sex characteristics as exhibited by the growth of combs and wattles, wing-stretching and crowing, could only be attributed to the increased levels of testosterone in the experimental group.

#ORDER LEPIDOPTERA TRANSGEOGRAPHIC PHENETIC EXPRESSION

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The purpose of this experiment is to determine if Lepidoptera obtained from divergent geographic regions possess wing scales which demonstrate taxonomically sensitive structural affinities. If so, then numerical models created for rapid specimen identification can be universally formulated from a regionally limited specimen pool.

In my previous experiment, taxonomic models were formulated which defined Pennsylvania specimens on the subfamily level of classification. In order to test the reliability of such models within the geographically inclusive taxonomic work of the Order, specimens collected from California areas were added to the accumulated data.

Results show that scales taken from the discal cell of the forewing demonstrate phenetic stability when both diurnal and nocturnal species from disjunct Lepidoptera populations are compared. Consequently, the creation of models defining individual species has been accomplished. It is now possible, applying varying degrees of confidence, to assign subfamily and genus status to specimens of unknown origin.

Utilization of this simplified method circumvents wing venation and genitalia dissection techniques presently used in systematic work of the Order. Computerized species models also track the mathematical dynamics reflecting evolutionary divergence. Numerically noted character variance within western United States Pieridae specimens implies the presence of an undefined species.

#First Award - Entomological Society of America
First Award - General Motors ISEF/Zoology
Scholarship - U.S. Navy

EARLY BIRD SONG AND EARLY LIGHT - RELATED?

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Purpose: The purpose of the project is to show the relationship of the onset of early morning birdsong to increasing daylight.

Procedure: For 39 days the following data was recorded from 6:45-6:55 A.M.: temperature (in celsius); light intensity (light meter, shutter speed of 60); number of birds; time of sunrise, and amount of cloudcover. This data was then analyzed by constructing scattergrams of each variable (except cloudcover as it was only observed in an informal way) against the number of birds heard. Then an analysis was done to find which variable affected bird calling the most.

Results: The results of the analysis are as follows:

1. +.967 correlation between light meter readings and number of birds.
2. -.556 correlation between time of sunrise and number of birds.
3. +.081 correlation between temperature and number of birds.
4. The analysis showed that light intensity was the variable that had the most effect on number of birds that sing.

Conclusion: The increasing degree of light intensity before sunrise is positively related to an increase in the number of birds that sing. The time of sunrise, temperature, and precipitation have no significant correlation to the number of birds that sing. This research supports the statement of Robert Burton (*Bird Behavior*, 1985) that "the start of the dawn chorus is related to light intensity." (126).

BIOLOGICAL ASPECTS OF THE COCKROACH *ASPIDUCHUS CAVERNICOLA* (REHN, 1951) (ORTHOPTERA:BLATTIDAE) FROM *SOUTHWESTERN PUERTO RICO*

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This investigation attempts to increase our knowledge on the cockroach *Aspiduchus cavernicola* (Rhen, 1951), an endemic cave dweller from southwestern Puerto Rico. This species is found living sympatrically with the cosmopolitan species *Periplaneta americana* (L.) and a comparative study between both species has been conducted.

The study involves description of cave, environmental parameters in a 24 hours period, taxonomy, population, competition, food items, physiology, behavior and internal parasites. Measurements of length and width of body, three legs, antennae and wings were taken for males and females. A phallus study revealed that *A. cavernicola* is a primitive roach

Chemical analysis was carried out to determine water, organic matter, mineral and protein content. Oxygen consumption, oviposition, righting response, range of antenna movement, velocity, soil preference and grooming behavior were studied. A parasitological study revealed over 800 nematodes living in the hindgut of *A. cavernicola*. They are in process of being identified.

Up to this point 13 instars have been found. Using photographs several tests have been performed; population study and measurements of the leg parts.

Strength tests of the two species of roaches were done and compared, statistical analysis of all the tests have been done.

#EFFECTS OF PHOTOPERIODS ON TOBACCO HORNWORM DEVELOPMENT

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The purpose of this experiment was to determine the effects of varying photoperiods on the developmental rate of tobacco hornworms. It was hypothesized that a certain total light amount was necessary to the development of the moths. The hornworms subjected to all-light conditions would accumulate their total hours first and develop fastest. The all-dark group would continue to develop, but at a slower rate. For example, the hornworms in a fifteen hour photoperiod would develop faster than hornworms in an eleven hour photoperiod.

The procedure focused on four groups of hornworms that were placed on bent wire screens in plastic shoeboxes lined with paper towels. Three boxes were placed in larger cardboard boxes with fluorescent lights and timers set at eleven, fifteen, and twenty-four hours of light per day. These boxes were placed on a large stand with heavy black plastic tarp around each to prevent light from entering the boxes. The fourth plastic shoebox was put into a large styrofoam box inside heavy black plastic sacks. This all-dark box was checked under a red light. Temperatures and development were recorded daily. Photographs were taken.

Daily observations concluded that the hypothesis was incorrect. Hornworms can develop successfully in darkness only throughout larval stages. Further development is impossible without some light. Shorter photoperiods of total light slow development by triggering diapause (temporary pause in development due to unfavorable conditions). Longer photoperiods enable hornworms to complete their life-cycles faster than any other exposure and they skip diapause.

#Third Award - General Motors ISEF/Zoology

# HUMIDITY DEPRIVATION RESULTING IN NON-VIABLE WING SUPPORT IN *MANDUCA SEXTA*

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The objective of this investigation is to determine the effects of a lack of humidity during the pupation period of the tobacco hornworm on its response to its sex pheromone, isoamyl acetate. *Manduca sexta* larvae were raised from eggs, and immediately following the pupation of each, the pupae were transferred to two separate chambers. One chamber was maintained at eighty percent humidity, while the other was kept at thirty percent humidity. After twelve days each pupa was massed and measured in length; on the average the pupae kept in the more humid conditions were larger and more massive than those placed in the arid environment. As the moths emerged, the males were placed in a wind tunnel to test their wing support and reaction to their sex pheromone. The dry pupae experienced physiological damage as a result of a loss of pupal fluid and could neither fly nor react to the pheromone in any way. The healthy moths were able to fly, and reacted strongly to the isoamyl acetate by wing fluttering, antennal movement, and tracking the pheromone source in the wind tunnel. The results of this experiment showed that as a result of a lack of humidity during the metamorphosis of *Manduca sexta*, moths developed which experienced severe wing deformities and an inability to react to the sex pheromone of their species. A natural disruption in the moths' normal habits and abilities can be created by placing the moths in unsuitable environmental conditions.

#Third Award - General Motors ISEF/Zoology

#NOTES ON THE BIOLOGY OF NEPHILA CLAVIPES IN SOUTHWESTERN P.R. WEB CONSTRUCTION AND ELASTICITY II

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Nephila clavipes which lives in tropical and sub-tropical areas, belongs to the orb-wearing spiders group. It is specially recognized because of its golden web and its resistance.

This research was carried out in three main parts: Web Construction, Material Characteristics and an Ecological Phase.

During the first phase of this research, 25 spiderwebs were collected. The purpose was to determine an specific construction pattern. Measuring each angle per quadrant (each web was divided with a Coordinated Axle System) in accordance with the rays, we couldn't obtain a measurement average because of the big difference of the angles measures. We could determine a pattern based on the quantity of rays per quadrant. Four construction patterns were established.

Fifty elasticity tests were done, which could help us to determine Free Body Diagrams. In agreement with these Diagrams, we measured the tension on each side of the thread caused by the weight application. In contrast to the materials logical behavior, the tension used to be smaller as you applied more weight. As weight increased, there was reduction of the crossectioned area and the thread diameter shrank. There is a close relation between the strain and the stress of the thread. This relation determines a graph that shows the tread's internal behavior. This graph showed that the thread starts with an elastic behavior but it changes to an irregular behavior. This demonstrates that is has plasticity. The thread is an elastic--plastic material. These charachteristics are the same ones we can find in steel.

We are developing an ecological phase on which "strange spiders" on Nephila's web are under investigation.

#Second Award - General Motors ISEF/Zoology

#THERMOREGULATION BY REFLECTANCE BASKING IN BUTTERFLIES

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This study investigates the possibility that as butterflies bask in the sun, they position their wings in a broad or narrow V to reflect the sun's radiation onto their body. Due to a limited amount of research on this topic, however, the data-collecting techniques are original. By creating a model of a butterfly using real butterfly wings, the angle of the wings could be changed to any angle, and the effects of these changes can be detected in the body temperature of the artificial butterfly body.

Having analyzed the data collected from the model, I could conclude that there is not a great difference in body temperature between the species when the angle of the wings are the same. However, there is a sizeable temperature difference in every species as the reflectance V becomes broader, suggesting that when the angle of the wings are between 30 and 45 degrees, the optimal angle has been reached for all four butterflies.

Reflectance basking represents only one method of thermoregulation in butterflies. It only cracks open a little piece of their life functions, but it is one of the most important functions that influences all the other activity of the butterfly--the control and regulation of its body temperature.

#Third Award - General Motors ISEF/Zoology

# POSSIBLE EFFECTS OF IMPOSED STRESS DUE TO SLEEPLESSNESS ON THE IMMUNE RESPONSE OF LABORATORY MICE

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Psychological as well as physiological changes have been associated with sleep deprivation.(Kleitman) Personality changes include increases in hostility, depression and confusion. Physiological changes include a decrease in body temperature and fluctuations in pulse rate and blood pressure. I was unable to locate any articles indicating a relationship between sleep deprivation and the immune response system.

Twelve, Swiss-Webster female lab mice, 22 weeks old, were divided into 2 groups: *Control-no-stress* -regular (12-12hrs) awake -sleep patterns *Experimental* -sleepless period of 48 hrs. immediately prior to bacterial challenge. The mice were maintained on Purina Rodent Chow, ad lib. for 4 wks prior to the test. The experimental mice were placed in an approved slowly rotating chamber designed in such a manner (partial water bath) that the mice could not sleep for the designated period of time. At 4 wks, differential WBC counts were determined. At 5 wks, leukotaxis and phagocytosis percentages were determined following an *E coli* challenge (Burrell's procedures). Data were evaluated using the T-test.

Sleep deprivation was found to enhance leukotaxis but depress the % of leukocytes performing phagocytosis. There was no significant difference found in the differential WBC counts.

#Second Award - U.S. Air Force
Fourth Award - General Motors ISEF/Zoology

#INHIBITION OF PHOTOTAXIS BY ULTRAVIOLET LIGHT IN *DROSOPHILA MELANOGASTER*

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Many insects including wild-type *Drosophila melanogaster* are positively phototaxic. In previous studies, quantitative measurements of the physical activity of *Drosophila* were obtained using a phototaxic stimulus in a calibrated apparatus. After a 20 minute ultraviolet (UV) light exposure (254 nm), the adults demonstrated a marked decrease in physical activity.

The phototaxic response is dependent on light perception by the visual organs as well as the ability to move in response to the light stimulus. This study examined whether the decrease in physical activity of *Drosophila* is due to a loss of phototaxis or a decrease in physical mobility. Experiments were designed to examine variables of adult age and the temperature during UV exposure. To determine whether UV exposure of the eyes (head) or body (thorax-abdomen) was important in the reduction of physical activity, the results of whole body and regional body exposures were compared.

Physical activity was found to be dependent on the age of the organism with lower activity values being recorded in older populations. Activity and phototaxic responses after UV exposure depended on the temperature during exposure. Decreases in mobility occurred when either the head or thorax-abdomen regions were exposed. An analysis of the results suggest that the response to the UV light is influenced by several variables that affect decreases in phototaxis and physical activity to differing degrees.

#Fourth Award - General Motors ISEF/Zoology

SUBSTITUTION IN CHICKEN EMBRYOLOGY

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This is a study to see if substitution of an incubator for a hen will effect the development of the embryo. In the regular incubator the eggs did develop as if under the hen. time had to be tanen to make sure the moisture provided by a water bowl was at a good level at all times and that the temperature was kept by a light bulb. Time and careful work went in to this. thus the idea of a waterbed. the moisture would be at a good level and water keeps a good level temperature wothout changing as much. The eggs are to be opened every three days to check growth and make comparisons between the two. The eggs will be rocked on the water-bed instead of having to be turned by hand three times a day.At this point the waterbed eggs are developing three days faster than the conventional incubator is doing.

MIXED BREEDING OF HAMSTERS

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Initial reference materials state that cream-colored and long-haired traits are recessive in hamsters. My experiment set out to prove that when a long-haired, cream male hamster and pure-bred, short-haired golden female hamster are mated, two generations would be necessary for these recessive traits to become visible.

The plan was to mate the above two hamsters and then mate the male with one of the female offspring in order to obtain the recessive traits. However, long-haired and cream hasters resulted from the initial pairing along with a variety of other colors. Pairing the original male with a short-haired cream female offspring produced only cream babies with both short and long hair lengths. When a golden short-haired female offspring was bred with the original male, both short and long-haired babies resulted with a variety of colors including cream.

Conclusions are as follows:

1. The original golden female was not a pure breed but included both cream-colored and long-haired genes.
2. The determination of color is much more complex than just a single dominant/recessive pairing of genes.
3. Both the long hair and cream color are recessive.

EFFECTS OF WINE COOLERS ON PHYSICAL APPEARANCE, MENTAL-MOTOR RESPONSES

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This study was conducted to determine whether exessive use of wine coolers affect physical appearance as well as mental and motor responses of users. The hypothesis was that these beverages can have harmful effects. This problem was researched in four phases using two male hamsters of the same age, size, and parentage. Phase One was an observation of normal behavior and appearance of animals; Phases Two and Three, comparison of subjects with one on wine cooler; and Phase Four, observation of hamsters with both on water. The results of the study showed that a marked difference in behavior, appearance, weight, and coordination existed between the animals in Phases Two through Four. However, while the study showed that excessive amounts of wine coolers can be harmful to small animals, more research is needed to define excessive and to determine the effects of wine coolers on larger animals.

STUDY OF THE SYMBIOTIC RELATIONSHIP BETWEEN THE ANEMONE *STOICHACTIS HELIANTHUS* AND THE SHRIMP *PERICLIMENES RATHBUNAE* IN SOUTHWESTERN PUERTO RICO

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Carr 101, Km^2; Hm 1 Interior Bo Ancones, San Germán, PR 00753

Palaemonid shrimps of the genus *Periclimenes* are well known for their peculiar behavior of living in association with sea anemones in a type of symbiotic behavior known as cleaning symbiosis. This study represent an attempt to elucidate the mechanisms underlining the symbiotic relationship between the shrimp *Periclimenes rathbunae* and the anemones *Stoichactis helianthus* and *Homostichanthus duerdeni*. Some attention has been paid to two other shrimps found in association with said anemones, *Thor maningi* and *Thor amboinensis*. A colletion of 459 anemones in the eleven stations covered in this study revealed 2,408 shrimps.

Host specificity trials were conducted to test the preferrence of the shrimp towards the two natural hosts and ten other possible ones. Three controls were used.

P. rathbunae preferred the tentacles of *S. helianthus* over all others 65% of the time in a time of 150 sec.

Test conducted to find out of the shrimps locate the host in its natural environment using his vision or olfaction showed that apparently neither plays an important role along this line. The shrimp may locate the host at a distance of 30 cms.

Other organisms were found in association with the anemones this investigation has revealed what are considered is a new type of cleaning symbiosis since it differs from the well known patterns that had been established previously by Conrad Limbaugh and Howard Feder. The shrimp does not remove parasites from the host but rather clean the host from damaged tissues.

INSULIN SECRETION AND METABOLISM: RESPONSE TO D- AND L-GLUCOSE

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People face many health problems most of which seem to be complicated by obesity. Diabetes is one of the leading diseases in our country and is also complicated and sometimes even brought on by being overweight. This project explores the possibility of using L-glucose as an all natural sweetener that would neither contribute to the complications of sugar related diseases or to weight problems.

L-glucose and D-glucose are enantiomers of each other which means that both molecules have the same components but one's structure is the mirror image of the other. Since the enzymes of the digestive tract are specific to D-sugars, they are not able to act on L-sugars. The same should be true for the secretion of insulin. It is hypothesized that "glucoreceptors" will not be able to recognize L-glucose molecules and stimulate the beta cells to secrete insulin.

In the first experiment L-glucose was tested with the enzyme, hexokinase, which phosphorylates the glucose molecule upon entering the cell. Glucose must be phosphorylated if it is to continue through metabolism. L-glucose was not acted on by this enzyme.

The next experiment involved insulin secretion in rats. Ten rats were tested for insulin after being fed D-glucose (standard), L-glucose (test), and water (control). Each rat was tested with all three substances with two days in between each to insure one test did not affect the other. Blood was taken 5 minutes after glucose administration and serum insulin levels were found by radioimmunoassay. There was no increase in insulin levels for L-glucose.

THE AFFECTS OF ROENTGEN RAYS ON *MUSCA DOMESTICA* IN DIFFERENT STAGES OF METAMORPHOSIS THROUGHOUT THE F2 GENERATION

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Because of nuclear reactors, nuclear weapons, and talk of nuclear war, radiation has become a major controversy in the last few decades. My project was to explore the effects of an X-ray on *Musca domestica* in two different stages of metamorphosis throughout the F2 generation. The two groups I chose to observe were the offspring and the pupae forms of metamorphosis. I irradiated the P1 generation of the adult group and irradiated the F1 pupal stage of the pupae group. Four basic problems I wanted to observe were how the radiation affected [a] the hatch rate, [b] the mutation rate, [c] the mortality rate, [d] and the F2 generation.

I irradiated the *Musca domestica*, gathered eggs, cultured eggs through metamorphosis until hatched into adult flies. I observed the flies through a stereoscope recording normalities, abnormalities, and mortality rate as well as the number of npupariums compared to the number of adult flies. I repeated the process for culturing eggs through metamorphosis to obtain an F2 generation.

I found that the radiation had an effect on both the offspring of irradiated P1 generation and the irradiated pupae. The control hatch rate was 63%, mutation rate was 13%, and mortality rate was 6%. The F1 groups of irradiated P1 generation had a hatch rate of 78%, a mutation rate of 50%, and a mortality rate of 31%. The F1 group of irradiated pupae had a hatch rate of 54%, a mutation rate of 44%, and a mortality rate of 52%. I found that the majority of the flies were sterile and unable to produce an F2 generation, but the few that reproduced produced normal, non mutated offspring. Thus radiation has major affects on the *Musca domestica*.

THE EFFECT OF CAFFEINE AND NICOTINE ON EMBRYOS OF *RANA PIPIENS*

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The purpose of this investigation was to see if nicotine or caffeine can slow or arrest embryo development in frogs like these chemicals are suspected of doing to human embryos of mothers who smoke or consume large amounts of caffeine. Frog embryos in the blastula stage were placed in water containing caffeine, nicotine or a mixture of caffeine and nicotine in concentrations of 1:100, 1:1000, 1:10,000 and 1:100,000. The embryos in the concentrations of nicotine 1:10,000 or stronger and of caffeine 1:1000 or stronger did not develop into tadpoles. The other concentrations of nicotine or caffeine all yielded some tadpoles, but many developed slower or were smaller and none developed as fast or had as high a hatching rate as the control embryos. Also, embryos in the same concentrations developed at different rates or would stop developing. Generally, the nicotine effected the embryos more than the caffeine. The slower development and the smaller size of the embryos in the caffeine and nicotine would support the association of lowered birth weights and miscarriages with maternal smoking and caffeine consumption.

#EFFICIENCY OF MEIOTIC GENES IN FLY CONTROL

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This project was aimed at using a more efficient and economical approach to eradicate the Oriental, the Melon,and the Mediterranean fruit flies in Hawaii. It is one which involves the "meiotic drive" complex in *Drosophila melanogaster* and genetic engineering. The first objective was to create a strain of flies with a sex-linked drive such that it would cause extinction of the population owing to a deficiency of one sex. The Rsp gene was translocated to the Y-chromosome. Introducing the SD and RCy 40bw (enhancer to SD) in the next mating to act on the Rsp gene at its new site, the sex ratio was distorted to 7.2% male:92.8% female. I hypothesized that if the Rsp gene was translocated to the X-chromosome, the sex ratio would be reversed.

To guarantee the efficiency of this model in nature, I tested the effects of mutagenic agents (P-elements and X-rays) on the translocated Rsp gene using various genetic schemes (including the use of meiotic mutants,pn and K-pn). The hybrid dysgenesis induced by the P-strain appeared to have made the Rsp locus insensitive to SD action. The data also showed that X-irradiation (2,000 rads) is not a threat to the release of the T(Y;2)Rsp strain.

The work of this project supports the use of T(Y;2)Rsp strain to control fly population. Further research will be to create similar strains in the 3 species of fruit flies that are damaging our produce in Hawaii.

#First Award - American Medical Association

First Award - General Motors ISEF/Zoology

CALCIUM AND ITS EFFECTS ON CHICK EMBRYO DEVELOPMENT

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Since the discovery that injesting calcium can help increase bone density, many people, especially pregnant women, have begun to add large amounts of calcium to their diets. This project attempts to determine the effect of various concentrations of calcium on chick embryo development. Calcium was injected during the third day of development, eggs were opened on the 18th day, and embryonic growth was analyzed. Initial results indicated that the calcium had a statistically significant adverse effect on embryonic growth. An attempt is now being made to find the mechanism that triggered the abnormal development. Three mechanisms are under consideration: 1) hormonal imbalance related to parathyroid hormone; 2) rapid contraction of muscle myofilaments; and 3) a change of water balance in the kidney. Current research on copepods and daphnia suggests that calcium may cause a difference in the contractions of heart and digestive systems. This indicates that muscle failure may be the cause of abnormal development in the chick. Further research is being conducted to test calcium's role on the membranes of vacuoles in paramecium, since hormonal control and water balance is determined in part by the ability of molecules to carry messages across the cell membrane.

Damage Of White Flies To Five Species Of House Plants

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The purpose of this project was to see what effects white flies would have on five different house plants. These plants included the following: African Violet, Asparagus Fern, Impatien, Jade and Philodendron (a vine).

The hypothesis was that the white flies would multiply most rapidly on and do the most damage to the Jade plant and the African Violet because these plants have large, thick leaves and stems. The Asparagus Fern, Impatien, and Philodendron would be unattractive to and would repel the flies because these plants have small, thin leaves.

The white fly is the common name for many species of highly destructive insects of the family Aleyrodidae in the Order Homoptera. This order also includes cicadas, aphids, and scale insects.

The results of this experiment partially verified the hypothesis.White fly larvae attached themselves to all the plants except the African Violet. Leaf damage was most extensive in the Impatien, followed by the Jade, Philodendron and Asparagus Fern.

This project has taught me that white flies can be very destructive to house plants. White flies reproduce in great numbers and spread quickly among healthy plants. One of these five plants may repel white flies, but they will eventually move on to other vulnerable plants that they can feed and nourish on.

HORDEUM H. VULGARE. DOES SPROUTING HAVE AN EFFECT ON CATTLE GROWTH?

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Hordeum H. Vulgare. Does sprouting have an effect on cattle growth? Commonly known as barley, Hordeum H. Vulgare is a common cattle feed in the midwest United States. A new company, Aquaerop, has developed a machine to sprout barley and the researcher wanted to test the effects of this new product in the feeding of cattle.

Nine cattle were fed on the sprouted barley and nine others, the control, were fed on whole barley grain. After the first period, consisting of twenty-one days, the cattle on the grain pulled way ahead of the sprouted group. This was partially due to the reluctance of the sprouted group to begin eating the feed. By the second period, the sprouted group was gaining better than the whole grain group. In the third and fourth weigh periods, gains were lower due to bad weather conditions and the fact that four animals from each group were halter broken.

The researcher feels that this product is not economically feasible to be used as a supplement in feedlots at this time with the abundance of land. We can't afford to have that three week adjustment period. In the future though, the use of this product may be necessary when there is a shortage of land, but still a need for the production of cattle.

CAN THE DIFFERENCE IN THE RATE OF REGENERATION DUE TO FRATERNIZATION BE ATTRIBUTED TO PHYSIOLOGICAL FACTORS

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Introduction: The regenerative power of the mitotic cell accounts for life's ability to grow new as well as replace damaged or worn out cells. The results of phase one of this experiment suggested that an increased rate of regenerative power could be accounted for by camaraderie. Phase two, this years project, reiterated last year's results plus it suggested that this increased rate of regeneration due to fraternization could be attributed to physiological factors.
Procedure: Several hundred planaria were obtained and divided into groups of 1,5 , 10, and 20 planaria per dish. After 3 days of adapting to this new environment each planarian was cut to induce regeneration. This part of the experiment was carried out 5 times simultaneously. More planaria were obtained and divided into the same number of groups: however, there was only 1 planarian in each dish. The water from the corresponding groups in experiment one was used. Again each planarian was cut and the results were noted.
Results: Experiment one suggested that fraternization caused a decrease in the rate of regeneration of cells. Experiment two suggested that this decreased rate might be attributed to physiological factors.
Discussion: Application of such evidence could lead to improvement in shortened length of hospital stays, better care for gerentological patients, and even possible injections of fluids to aging or worn cells.

#CYTOLOGICAL AND MORPHOLOGICAL PROFILES OF TWO LIZARDS OF THE FAMILY GEKKONIDAE: GENUS: HEMIDACTYLUS

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Hemidactylus brooki haitianus and *H. mabouia* are the only two representatives of this genus in Puerto Rico, being *H. brooki haitianus* the one with the bigger distribution in the island, (Rivero, 1978). These are nocturnal lizards, but can be seen during the day in shadowly places.

Observations related to their morphology revealed that *H. brooki haitianus* is bigger in size and weight when compared to *H. mabouia*.

This investigation attemps to produce in the future a new key to be able to differentiate these geckkos based mainly on hematological evidence. Results to this moment show that the hemoglobine content of *H. brooki* is almost identical to that of *H. mabouia*, 7.8 gm to 7.7 gm respectively. However, separation by sexes shows a marked difference among the females (7.6 gm for *H. brooki haitianus* and 6.1gm for *H. mabouia*). In males the average was similar. The hematocrit shows that in females of *H. brooki haitianus* it is higher than in females of *H. mabouia*. The opposite occurs in males where the percentage is higher for *H. mabouia*. Other tests such as differential counts, blood cell counts and proteins were in carried out.

Direct observations showed that the color of the color of the eyes in both species varies with a tendency towards a copperish coloration and greenish for *H. brooki haitianus*. This brought about a study of the eyes pigments and cells of the eyes of these species. Results show there are differences in the eye pigments among both species.

During the investigation we found the presence of both endoparasites and ectoparasites. A mite of the Family Pterygossomidae was found to be common for both species of geckkos.

Endoparasites consisted mainly of nematodes and the pentastomides *Raillittiella hemidactyli* Hett (1934).

A study of the chromatophores on the scales of several areas of the skin of both species was carried out. A photographic analysis was carried out.

#Fourth Award - General Motors ISEF/Zoology

# The Toxicity of Heavy Metals and Their Removal

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Generally, the toxic effects of heavy metals have been known for quite some time and concerns have been shown by the government, industry, and academia. The EPA set standards for allowable levels of heavy metals in discharged wastewater believed adequate for the survival of most organisms. The effects of sublethal concentrations are considered very rarely, if at all; yet these concentrations endanger the existence of many species. They act as enzyme inhibitors or stimulators that may effect growth and reproduction, cause genetic defects, alter membrane permeability, impair protein synthesis, or distort nuclei acid structure.

In this study, a specific effect of copper cations on eleuterembryos of some fish has been discovered. Copper concentrations much lower than the EPA standards inhibit the function of glands producing adhesive mucous filaments. As a result, the hatching embryos are unable to attach themselves in strata with a sufficient level of oxygen, descend to the bottom and suffocate.

Subsequently, a method was developed for practical, safe, and inexpensive removal of heavy metals from water by introducing hydrogen sulfide to react with heavy metal ions to form insoluable sulfides. The process, applied for U.S. patent, has potential for broad environmental and industrial applications.

#First Award - Eastman Kodak Company
First Award - General Motors ISEF/Zoology
First Award - Patent and Trademark Office/U.S. Department of Commerce/ Patent and Trademark Office Society

A COMPARATIVE STUDY OF CHEMORECEPTOR CONDITIONING IN GASTROPODA LYMNAEA STAGNALIS AND HELISOMA TRIVOLVUS

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Research was conducted on two species of aquatic snails; the pond snail (Lymnaea stagnalis) and the ramhorn snail (Helisoma trivolvus) of the phylum mollusca, class gastropoda. Two groups of each species were composed of ten snails each. A control group and an experimental group was designated for each species. Each snail was weighed and measured and data recorded. A training phase consisted of starvation of each group for a two day period prior to experimentation. Rasping of the mouth was observed for both control and training groups. Both groups were subjected to small amounts of amyl acetate at feeding time and the number of rasps recorded for each species. This procedure was performed at five different testing periods over a two month period with average results recorded for each group. Training was performed prior to actual testing for conditioned responses. The testing phase consisted of subjecting conditioned unstarved snails to dilute solutions of amyl acetate and then counting the number of rasp responses. Numbers of rasps for the control group were then compared to the rasps of the trained group to determine the extent of chemical conditioning through chemoreceptor response. Data obtained from observations indicated that in both species, positive correlation existed between the number of rasps and the amyl acetate response. It was concluded that in the species Lymnaea stagnalis conditioning was very positive as shown by a substantial increase in rasping responses as compared to Helisoma trivolvus. Variables such as weight, size and etc., apparently play little or no role in the ability of aquatic snails to be conditioned. Research concluded that invertebrate gastropods may be conditioned to respond to stimuli indicating conditioned behavioral patterns.

#ULTRASONIC VOCALIZATIONS IN PRAIRIE VOLES

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Ultrasonic vocalizations are auditory signals above the range of human hearing. In many species, adults emit these signals for social communication. The vocalizations are often associated with courtship and sexual behavior. Male and female prairie voles, Microtus ochrogaster, were presented with anesthetized and unanesthetized (awake) conspecifics, while ultrasonic vocalizations were monitored using a bat detector. In the first experiment, males produced significantly more ultrasounds than females during the five minute testing sessions. Very few ultrasounds were detected when females were tested with other females or anesthetized males. In experiment 2, males tended to produce more ultrasonic vocalizations to unfamiliar females than to familiar female siblings. Since siblings avoid inbreeding in this species, it is not suprising that males emit ultrasonic "courtship vocalizations" to potential mates than to familiar female siblings. Finally, sexually-experienced males emitted significantly more ultrasonic vocalizations to anesthetized females than did sexually-inexperienced males. These results suggest that ultrasonic vocalizations are an important component of a communication system which coordinates reproductive behavior.

#Third Award - General Motors ISEF/Zoology

INSECTICIDE PROPERTIES OF CITRUS PEEL OILS ON CTENOCEPHALIDES FELIS

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Millions of dollars are spent annually on foggers, sprays, dips, shampoos and collars to control flea populations on dogs and cats. Many of the chemical insecticides contain harmful ingredients, particularly cholinesterase inhibitors which are potentially hazardous to humans and pets. Natural plant and animal products which exhibit insecticidal properties and yet are not toxic hold the hope for safe yet effective means of flea control. Oils of citrus fruit peels have been shown to contain limonene, a highly effective insecticide against flies. The purpose of this project is to determine the effect of citrus peel oils on eggs of the common pet flea, Ctenocephalides felis. Five citrus peel oils were tested on each of ten flea eggs. Ten eggs were left untreated and used as the control. This experiment was repeated twice. Oils of tangerine prevented 100% of the eggs from hatching. Oils of lemon and lime prevented 90-95% of the eggs from hatching while oils of orange and grapefruit prevented 80-90% of the eggs from hatching. Oils of citrus show great potential as a natural product which could be used safely in the home to eradicate flea populations by preventing the eggs from hatching.

#MULTIPLE GALL SYSTEMS IN CHRYSOTHAMNUS

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This project on the gall systems of *Chrysothamnus* is in its fifth year of research. In the last five years I have worked on the following: (1) methodology for hatching, observing and identifying the various gall inhabitants, (2) identifying which inhabitants cause the galls and which occupy the galls as secondary dwellers, (3) identifying which of the secondary dwellers were parasites and which were just "free loading", (4) transplanting Chrysothamnus for studies in a greenhouse, (5) counts of various gall forms to establish gall frequency, (6) artificial production of galls using pupal and larval extracts, (7) the construction of an isolation chamber to allow gall formation to be photographed, (8) identification and cataloging of the types of galls found in the *Chrysothamnus* system, (9) use of the isolation chambers to follow mating, egg production, and consequent gall formation, (10) attempts to find any previously unidentified gall forms within the *Chrysothamnus* system, (11) attempts to bring about the formation of the gall form caused by the cynipid wasps in similar fashion to the work done with the tephritid flies, (12) attempts to isolate and identify the various parasites that seem to be part of the *Chrysothamnus* system, (13) attempts to have all insects involved scientifically identified. The research has been very successful and exciting and I plan to carry on the research into graduate school.

#Second Award - General Motors ISEF/Zoology

VARIETIES OF FOSSARIA-CUB. DETERMINED BY ELECTROPHORESIS TECH.

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In this study, the investigator demonstrated that electrophoresis can be used to identify varieties or strains of the snail *Fossaria (Lymnaea cubensis*, intermediate host for *Fasciola hepatica*. Strain differences among these snails are observed through their reproductive capacity. The area where *F. cubensis* strain has the greatest reproductive capacity, is the area in which the parasite *F. hepatica* is the most prevalent. However, when morphological differences between species do not establish with certainty the strains, electrophoresis is a convenient tool to define the differences. Electrophoresis is the method where proteins migrate in an electric field through a matrix of gel, starch, paper or cellulose acetate. The snails used in this investigation were *F. cubensis* species from different areas in Puerto Rico, the United States and *Lymnaea viator* from Perú. In this study electrophoresis was conducted only with the strains of snails from Las Piedras and Dorado, Puerto Rico. Strains of snails from Baton Rouge, Louisiana and Arecibo, Puerto Rico was used to establish differences in snail productivity. The horizontal electrophoretic apparatus made by this investigator with a starch matrix was used for identification of the varieties of *F. cubensis*. We used four (4) enzymes systems to differentiate and start the "strains of *F. cubensis* in Puerto Rico; which were: fosfoglucomutasa, hidroxibutirato hidrogenasa, isocitrato dehidrogenasa, and fosfoglucosa isomerasa.

THE BEHAVIORAL PATTERNS OF THE *SPALANGIA NIGROAENEA* IN LIGHT AND DARK ENVIRONMENTS

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Emphasis of this project is on observing *Spalangia nigroaenea's* preference for light or dark environments. It's the best parasite for stable fly control in cattle feedlots of Western Kansas. Results suggest a means by which the parasite can be mass-produced in the laboratory for release into its natural environment. Laboratory data and field data are compared to determine the reliability of mass-production.

In the laboratory, six cages containing parasites and fly pupae are exposed to light, and six similar cages are held in darkness. Stung pupae are exchanged for fresh pupae daily until all female parasites die. The number of parasites emerged from stung pupae is recorded.

In an outside experiment, four cages housing parasites have pupae placed above cattle manure, and four similar cages have pupae positioned below manure. For fourteen days parasitized pupae are exchanged for unparasitized pupae. The number of parasites emerged from stung pupae is recorded.

50 and 343 parasites emerged from pupae gathered from "light" and "dark" cages respectively. Progeny production in "dark" cages is six times the progeny in "light" cages. The parasite is best reared in the laboratory in dark environments.

208 and 178 parasites emerged from pupae placed above maure and below manure respectively. These parasites don't favor light or dark. Laboratory results don't match field results because outside surroundings influence the rate of oviposition.

A COMPARISON OF THE EFFECTS OF LEAD OXIDE AND LEAD ACETATE WITH VITAMIN D ON LUMBRICUS

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In studying the effects of graduated amounts of Lead Oxide and Lead Acetate with Vitamin D on Lumbricus, three phases have been studied thus far. In Phase One, the effects of Lead Oxide Red and Vitamin D were observed on 500 Lumbricus. In Phase Two, the effects of water-soluble Lead Acetate and Vitamin D were observed on 500 Lumbricus. In Phase Three, the effects of water-soluble Lead Acetate and water-soluble Vitamin D were observed on 500 Lumbricus. The Lumbricus were observed as to size, cocoons, juveniles, number, mass, and color, pre and post experimentation time period in each phase. Statistical analyses (t-test and chi square) were performed on the data collected. In higher concentrations of Lead Oxide and Lead Acetate, there were reduced number of Lumbricus. In higher concentrations of Lead Oxide, Lead Acetate, alone and with Vitamin D, there were decreased numbers of cocoons and juveniles. Lead Oxide and Lead Acetate appear to retard reproduction of Lumbricus. Water-soluble Vitamin D appears to increase juvenile activity.

#CIRCADIAN RHYTHMICITY AND AMINO-ACIDS ON BLASTEMA DEVELOPMENT IN REGENERATION

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This experiment investigated the importance of 24 hr. biological rhythms and nutrient cycles during regenerative blastema development. Planaria were cultured in Light/Dark 14:10 under flourescent lights. Ten worms were dissected at the 2nd,8th,14th and 20th hr. of their circadian oscillations. Blastemal growth, survival, and differentiative patterns were observed. Then in 2 trials, 20 worms were dissected at each time interval and macerated. Segmental remains were centifuged, and exposed to a protein assay. Through a spectrometer, the micrograms of protein found per 1 millimeter of worm was determined for each group. The first experiment was repeated so that 20 worm segments were allowed to regenerate in 0.001 M solutions of the amino-acids L-serine, L-methionine, L-threonine, and L-aspartic acid at each time interval. Regenerative ability peaks at the 20th hr. The nadir is at the 14th hr. The trauma of dissection at the 14th hr. theoretically disrupts the cellular peak in mitotic and gene induction activity. The rhythm in the free protein content segments peaks at the 2nd hr. and drops severely at the 14th hr. Methionine, Serine and Threonine supplements have the greatest impact on blastemal development when administered to worms dissected at the 8th hr. of their circadian rhythm. Threonine and Serine followed identical impact patterns, and were the most efftive amino-acids, possibly due to incorporation into Nerval Growth Factor and proteoglycans. The isotonic medium created by aspartic-acid's negative charge prevented amputation wounds from healing. The data strongly suggests that circadian rhythmicity, as reflected by 24 hr. intracellular nutrient cycles, directs cellular differentiation in an embryonic morphogenic field.

#First Award - U.S. Air Force
Honorable Mention - National Aeronautics and Space Administration

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An Investigation of the Anitmicrobial Properties of Mucus Found on the Ictalurus punctatus

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Mucus glands, which aid in maintaining water balance, and offer protection, are extremely numerous in the epidermis of *Ictalurus punctatus.* This was a two part investigation into the anitimicrobial properties of the mucus found on the *Ictalurus punctatus.* First four groups of *Ictalurus punctatus* were isolated. Two groups (#1 experimental-mucus removed, #2 control-mucus present) were placed in sterile well water, and two groups (#1 experimental-mucus removed, #2 control-mucus present) were placed in pond water, to determine if the mucus inhibits the growth of the *Aeromonas hydrophila* and *Chlamydia* on the *Ictalurus punctatus.* Secondly, the mucus was isolated and placed on agar plates with *Staphylococcus aureous* and *Staphylococcus epidermides*, to determine the effectiveness of mucus, found on the skin bacteria. The experiment showed that the presence of the mucus inhibited the *Aeromonas hydrophilia* growth on the catfish. However *Chlamydia* did not appear on any of the fish. This study rejected the initial hypotheses about mucus inhibiting the human skin bacteria. Both the *Staphylococcus aureous* and *Staphylococcus epidermides* continued to grow.

FEEDING BEHAVIOR OF THE MARINE COPEPOD *ACARTIA TONSA*

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A series of three experiments were conducted to study the feeding behavior and egg production of the marine copepod *Acartia tonsa*.

In each experiment, stage VI female *Acartia tonsa* and lab cultures of *Isochrysis galbana*(Iso) or *Scrippsiella trochoidea*(Scr) were used.

Experiment one was to determine the food preference of *Acartia*. Scr and Iso were the two types of food used. Experimental and control groups were arranged in 100ml bottles. Before the experiment, sample counts were taken from each bottle. Then the bottles were incubated for 4.5 hours. Sample counts were also taken after the 4.5 hour period. Frost's grazing equations were used to calculate the filtration and ingestion rates. The copepod preferred the *Scrippsiella*.

Experiment two was to determine whether or not different concentrations of food would effect the copepod's egg production. Different concentrations of Scr were placed in pitre dishes with filtered seawater. One copepod was placed in the experimentals for 6 hours. The dishes were then examined to count the eggs produced. The copepod produced more eggs at the higher concentration.

The third experiment studied the feeding of *Acartia* at varied temperatures. The experimental design was similar to that of exp. 1; but this time only one food source was used and the bottles were incubated at different temperatures(12°C and 19°). Frost's grazing equations were used to calculate the filtration and ingestion rates. Feeding was greater at 19°C.

The experiments lead to a better understanding of the planktonic food chain and its potential effect on the commercial fisheries of the inshore waters of the Gulf of Mexico which are in danger of saltwater intrusion.

STUDY OF THE CRABS FOUND IN THE SARGASSUM COMMUNITY ALONG THE SHORES OF SOUTHWESTERN PUERTO RICO

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Sargassum, a brown algae, member of the phylum Phaeophyta is commonly found among the sea weeds. Tropical regions have few species of these weeds, even through some of them, such as Sargassum may appear abundant. Sargassum is perhaps the largest brown algae in Puerto Rico as far as size is concerned. Also Sargassum offers an excellent habitat for many organisms of the litoral zone. The crab *Acanthonix petiverri* have been found among these organisms.

Measurements of the crabs body were made, length, width and weight were determined with values of 1.092cm., 0.896cm. and 1.2g. respectively. The specificity test revealed that *A. petiverii* prefers *Sargassum rigudulum* in 94% of the times with a mean time of 57.3 seconds. The vision test revealed that at a distance of 40cm., 20% of the crabs responded in a mean time of 99 seconds. In the light and dark selection test the crab went 65% to the dark side in 19 seconds and 35% to the light side in 38 seconds. For the color preference test the following colors were used: green, black, yellow, brown and red. The order of the colors was alternated for each test to eliminate any selection by position instead of a color preference. Most of the crabs selected the brown color, and in descendent order the black, green, yellow and finally red.

The study has revealed that *Acanthonix petiverii* prefers and live in *Sargassum rigudulum*.

#A BIOLOGICAL STUDY OF *ORTHOCRICUS ARBOREUS* (SAUSSURE, 1859) (DIPLOPODA:SPIROBOLIDA)

Torres, Yadira, Lola Rodríguez de Tió H.S., San Germán, P.R. 00753
Carr 348 km 15.4 Rosario Alto, San Germán, P.R. 00753

Orthocricus arboreus (Saussure, 1859) is a small to large millipede characterized by the shape of the male gonopods which is common throughout the Caribbean. In Puerto Rico it is quite common in the southwestern part of the island. Very little is known of the biology of this millipede besides the fact that it has several subspecies. This investigation represents the beginning of a desire to improve our knowledge of this species.

Millipedes studied in this work all come from 2 stations, Cain Bajo and Cain Alto in San Germán. Environmental parameters in which they are found include a relative humidity around 50-60%, a light intensity of 380-400 foot candles, a substrate temperature of 78°F, an air temperature of 28°C and a wind velocity of 9mph.

Measurements of length and width were determined. Length was 84.64mm ± 8.11mm. Width was 6.04mm ± 0.93mm. Number of legs and segments were recorded as well as their weight. The average number of legs was 202 legs, that of segments 52. Average weight was 2 grams.

Several aspects of the biology of this species have been studied. Velocity was .0111 m/sec. ± 5.82 x 10.5 m/sec. Geotaxic response was 2.12cm ± 17.90cm. Height preference range 1.37-3.48. They prefer darkness. Sixty percent of them showed a straight line movement pattern before centrifugation and 76% an irregular movement pattern after centrifugation. An average of 57% in relative humidity was prefered by this millipede.

A 100% of them survived an exposure of 2 hours underwater; 33% survived 4 hours. All died after 6 hours.

Parasitological studies revealed the presence of mites on the surface. Nematodes, gregarines and acarids were found in the hindgut. The incidence of infection was one of 100%. Fifteen species of nematodes, two species gregarines and one internal acarus have been found. A possible hyperparasite may have been found on the body of one of the nematodes.

At this time, an analysis of the directional system of this millipede is being carried out.

#Fourth Award - General Motors ISEF/Zoology

#THE EFFECT OF Ca^{+2} ON PLANARIAN REGENERATION

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It has recently been demonstrated that the entrance of Ca^{+2} into amputated planaria promotes the regeneration of lost body parts. As a result, this project dealt with 3 influences Ca^{+2} entrance has on the regeneration of *Dugesia dorotocephala*.

In one group of studies, it was demonstrated that the uptake of Ca^{+2} into amputated planaria promotes the appearance of glycoproteins on the blastema cell surface. This is significant for glycoproteins may convey positional information between blastema cells and, it is the blastema that becomes the missing structures during regeneration.

In another group of studies, it was shown that Ca^{+2} influxes also promote elevated levels of total RNA within regenerating planaria. It was also demonstrated that this Ca^{+2} regulation of RNA is mediated by Ca^{+2} activation of the regulatory protein calmodulin and by Ca^{+2} enhancement of cAMP levels. Thus, the entrance of Ca^{+2} may promote gene activation which leads to the synthesis of necessary proteins for planarian regeneration.

#Third Award - General Motors ISEF/Zoology

THE EFFECTS OF HONEY AS A PESTICIDE ON NASUSITERMES COSTALIS HOLMGREN

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The purpose of this study is to determine the effects of honey as a pesticide on Nasusitermes Costalis Holmgren (Tree Termites) instead of chemical pesticides. Studies of this insect show that on certain occasions they feed on each other.

I started by pouring honey on the entire surface of a nest of Nasusitermes Costalis Holmgren that was on a tree close to my home, as well as to the inside of the nest through an opening that I bore on the upper part of it.

I went to observe it for four days, took photographs and wrote down my observations. I also followed this process with a piece of the nest which I took home with me. In this case, I observed it through a magnifying glass and through my microscope.

On the fifth day I cut the nest open and I found that throughout the area where I had poured the honey the nest's gallaries were clean. The same happened with the piece I had at home. Any termites left were dead.

The honey stimulated cannibalism among them.

The finding presents the possibility of eliminating Nasusitermes Costalis Holmgren by natural and inexpensive means, without the hazards that chemical pesticides pose for man and enviroment.

#Honorable Mention - National Association of Biology Teachers

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A SIX YEAR INVESTIGATION INTO THE CONTROL OF CTENOCEPHALIDES FELIS

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The purpose of my project is to find the most effective methods to control the common cat flea, Ctenocephalides Felis, which is the flea that is most often found in Florida on house pets. The common cat flea is not only a problem to animals but can also infest the pet owner's home.

My hypothesis is that some products on the market are better than others in controlling the common cat flea, and my experiments determined which are best.

Over a period of years, I did experiments using flea powders, sprays, insecticides, and insect growth regulating chemicals. I tested citrus oils and chemicals to see if they can be used to effectively kill or repel fleas from animals. I set up controls, did replicates of experiments and compared results. I developed a formula for a home-made flea powder and set up experiments using it. I repeated an experiment using cotton to make the experimental environment more like cat fur.

I found that flea sprays kill more fleas than flea powders and that the home-made flea powder is more economical and more effective than commercial products. Insecticides used on carpets to combat all stages of flea growth are available through liscensed pest control companies. Of these, Durban and Ficam Plus were most effective overall in controlling both eggs and larvae; Methoprene killed more larvae but not eggs; Safrotin controlled the hatching of eggs slightly better than Dimilin. A computer statistical analysis was used to verify the results.

#Third Award - General Motors ISEF/Zoology

#AN INVESTIGATION INTO THE RELATIONSHIP BETWEEN GROWTH PATTERNS IN SELECTED SPECIES OF AMMONITE FOSSILS DETERMINED BY THE MEASURED CONSTANT ANGLE OF THE EQUIANGULAR SPIRAL

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In my research investigation I was trying to find if whorl growth patterns, exemplified in the form of an equiangular spiral, were species specific. I also wanted to compare these findings to the growth patterns of present day shells which exemplify this equiangular spiral. Determining whether or not these growth patterns were species specific and knowing how this information relates to present day shells would enable us to learn more about the environmental conditions of today as well as specific hereditary information. Possibly you could determine the species of a specimen by measuring the angle at which it grows.

I measured the constant angles of the specimens in my fossil group and discovered that they all grew at approximately the same angle, regardless of the genus or species. I also measured the constant angles of the specimens in my group of modern day shells. Their constant angles were also approximately the same, but significantly different from the fossil group.

My original hopes were to be able to determine the species of these animals by finding their constant angle; however, this was unsuccessful. Even though this was not what I wanted to find, it could show an interesting evolutionary factor has been imbeded in thier genes over million of years. Environmental conditions are another possible explanation fot these results.

#First Award - Eastman Kodak Company

CORRELATIONS BETWEEN AGE, SEX, AND WEIGHT IN *CASTOR CANADENSIS*

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In this project beaver skulls were cleaned, measured and their teeth examined. The purpose was to see what relationship exists between age, sex and weight in *Castor canadensis*. Each specimen was sexed and weighed prior to the head being removed. Because it was impossible to obtain the whole animal, these measurements were sent along with the raw skulls by a registered forester/trapper. After each skull was cleaned, the teeth were removed from the bottom right jaw and aged according to the method first developed by Van Nostrand. Each first molar was ground longitudinally and examined for porosity and cementum layering. Each animal was then assigned an age classification. Because of the small sample size it is unclear what relationship exists between age, sex and weight. It does appear, even from this small sample, that sex and weight have only a small correlation with age. My results suggest that osteologic measurements like "zygomatic breadth" and "coronoid to ventral surface" appear to be more reliable in affirming the age of any one group. The reason for this is possibly that a beaver's weight is more dependent on the availability of food rather than age. It should be noted that there currently exists no reliable method for aging live beaver. In order to determine population age structure, it is necessary to prepare skulls in the manner described in this project. An interesting research project might be to develop a method by which aging could be determined without sacrificing the animal.

EFFECT OF THE EXTRACTS OF DIFFERENT PLANTS IN AEDES AEGYPTI

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Three humdred fifty larvae in the third instars, were treated with an extract of the plants Artocarpus altilis (breadfruit), Allium sativum, Aloe vera (aloe), Sambucus mexicana (elder-tree), Nicotina tabacum (tobacco) and Tegetes patula (marigold).

The purpose in treating these larvae with these extracts was to investigate the possible properties they may contain as an effective and secure organic larvicide. The results of the investigation showed the following:

1. The extract of Allium sativum can kill 50% of the larvae in a period of 72 hours. During all the occasions that the experiments were repeated, I obtained the same results.

2. The extract of the marigold killed 16% of the larvae in a period of 32 hours, so it can be considered as a good base for a natural organic larvicide.

Our flora is rich and variable and it is an excellent source for research work.

A STUDY OF THE FACTORS AFFECTING INHIBITION OF GLAND DEVELOPMENT IN INSECTS BY A NATURALLY OCCURING ANTIALLATOTROPIN (ANTI-HORMONE)

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ABSTRACT: The purpose of this project was to determine if Precocene, and Juvenile Hormones #1, #2, and #3 have any effect on the development of Oncopeltus fasciatus. These chemicals naturally occur in the systems of insects. To begin, the chemicals were placed in petri dishes along with ten eggs. Several different concentrations of chemicals were used, but they seemed to have no consistency from concentration to concentration. The dishes were observed for a period of 25 days until the eggs had hatched and advanced toward maturity. The data was then gathered and analyzed. It was determined that Precocene causes a marked increase in the mortality rate and a decrease in hatching rates. Juvenile Hormone #3 decreases the mortality rate while increasing the hatching and growth rates. If the tested groups were placed on an arbitrary scale in order of maturity, from largest to smallest, they would be J. H. #3, control, J. H. #1, J. H. #2, and lastly Precocene. The main way in which these results could be applied would be to produce a natural pesticide using this antiallatotropin, Precocene, since it causes quick mortality and a very low hatching rate. Juvenile Hormone #3 would also make an ideal pesticide since it rushes the insect from instar to instar without letting the reproductive organs differentiate entirely.

#Fourth Award - General Motors ISEF/Zoology

*EFFECTS OF DIMILIN AND TBT ON FIDDLER CRABS, UCA PUGILATOR

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Within the last decade, the use of more specialized and biodegradeable chemicals has led to the development of the insect growth regulating compound diflubenzuron, marketed as Dimilin. Dimilin has been approved by the Enviornmental Protection Agency for a variety of uses since 1976. Unfortunately, Dimilin has been shown to affect one non-target group: the crustaceans. Another chemical of concern is TBT (tirbutyltin) which has been shown to be very neuro-toxic to a variety of estuarian animals. The use of TBT coatings in marine paints as an antifoulant has been promoted due to its excellent antifouling action, long duration of action, and its ability to prevent corrosion.
Fiddler crabs were divided into 14 groups of 20 crabs each. Ten crabs from each group were placed into trays with clean damp sand and the other half of each group was placed into a tray in which the sand was dosed with either Dimilin or TBT. Control groups were tested in all three types of trays. The number of burrows and crabs under the surface were counted every 15 minutes for one hour. T-tests were then performed as a measure of statistical significance at the $p=.05$ level. Results indicated that Dimilin caused a decrease in the number of both male and female crabs under the surface, and that TBT caused the females to burrows less, remain under the surface less, and perform their righting reflex faster.

*Third Award - General Motors ISEF/Zoology

EFFECTS OF POTASSIUM CHROMATE ON PLANARIA TIGRINAN REGENERATION

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This research was carried out to determine the effects of existing levels of the pollutant potassium chromate on the aquatic life of streams and rivers. Dugesia tigrina (Brown Planaria) was chosen because if it were affected by the potassium chromate, so would higher levels of the food chain be affected.

After determining non-lethal levels (9.71 ppm, 6.13 ppm, and 1.94 ppm), four groups containing ten planaria each were cut above the pharynx and four other groups were cut below the pharynx. Three groups were subjected to the different concentrations of potassium chromate, while one group was kept as a control. The planaria were monitored until the regeneration process had been fully completed.

From the observations it was concluded that potassium chromate retards the regeneration process of Dugesia tigrina.

#DO YOUR SOWS NEED MORE IRON?

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I was interested to see if a sow's production could be increased by injecting her with iron. I had already proved that higher hemoglobins were associated with larger litters. I found that the sow's hemoglobin level could be raised by injecting her with iron. I found that the litters were not always larger. I found that it is very critical to inject at the right time. I found that it is best to give the injection approximately two weeks before farrowing. I determined this by monitoring hemoglobin levels before farrowing, just after farrowing, and 3 weeks after farrowing. I also compared litter sizes. I found that the size of the litter is determined at breeding. I also found that this is the time when the sow's hemoglobin level is the lowest. I used iron to keep the hemoglobin levels up at this time. I found that the sow's next litter was over three pigs larger when she was injected with iron at the right time. A very small dose was used, but it seemed to be what she needed during the critical time of farrowing and lactating. I found that profit could be increased by over $30,000/year on a 100 sow farrow to finish operation using $43/hundredweight as the market price and $135/ton as the feed cost. This is a very substantial increase and could be a help to hog producers everywhere.

#First Award - American Veterinary Medical Association
Fourth Award - General Motors ISEF/Zoology

ORGANISMS IN LIMESTONE POTHOLES OF THE CHIHUAHUAN DESERT

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The purpose of this project was to determine what types of living organisms survive in the limestone potholes of Blue Mesa, a geographical cuesta in the northeastern part of the Chihuahuan Desert. Samples were taken from specific potholes located in the limestone surface of the cuesta and were brought to the laboratory for examination. Organisms from the kingdoms Monera, Protista and Animalia were found. Various types of algae and protozoans, as well as rotifers and nematodes, were identified. Two insects, a mosquito from the genus Culex and a midge from the genus Dasyhelea, were identified. One unexpected discovery was the midge, since members of Dasyhelea are tropical flies not common in cool, arid climates. Specimen were sent to Dr. W. Wirth, Cooperating Scientist, Systemic Entomology Laboratory, USDA. He confirmed that this was a species that had not yet been identified. Further research seems to indicate that the survival of this species in this particular area was due to the action of the American Indians hundreds of years ago. The Indians used the limestone potholes as grinding mills for mesquite beans. The grinding resulted in deep circular depressions in the limestone that allows the larvae of the midge to survive cold and arid conditions.

OTUS ASIO: POPULATION DYNAMICS AND PREDATION UPON MICROTUS PENNSYLVANICUS

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The initial purpose of this investigation was to determine by survey the screech owl population within a given area as well as the optimum weather conditions and habitat requirements necessary to locate these owls successfully. The results of this survey were then used to determine the peak activity of screech owls based upon such conditions such as time of night, darkness of night, and temperature.

After locating actual and approximate numbers of screech owls within the given study area, calculations were made to determine the environmental impact of the screech owl (Otus asio) upon its most common prey, the meadow vole (Microtus pennsylvanicus). Calculations were also made for their second prey, the deer mouse.

Through this investigation it was concluded that: 1) Time of night, temperature, or darkness of night are not limiting factors for peak activity, 2) Screech owl territory is 1/9 what previous studies indicate, and 3) The impact of screech owls on the percentage of meadow voles and deer mice eaten is significant. According to my calculations, between November 1 - March 31, the screech owls in the survey area will eat approximately 18.5% of the meadow vole population and 18.8% of the deer mouse population.

Since the screech owl is the most common predatory bird in the United States, the results of this study in terms of territory, impact on prey, and habitat requirements should be beneficial to researchers throughout the screech owls' range.

PLEIOTROPIC EFFECTS OF DILUTE, A NEW SPONTANEOUS MUTATION IN THE SYRIAN HAMSTER, MESOCRICETUS AURATUS. STUDY II.

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The purposes of this project are to determine the effect of the gene cream on the phenotypic segregation of offspring of dilute animals, to determine whether the male or female dilutes are responsible for delay in onset of reproduction, and to compare pigment banding patterns of hairs from wild type and dilute animals.

Data for analysis were obtained from four type of crosses: dilute by dilute, dilute male by wild type female, wild type male by dilute female, and wild type by wild type. Hair samples were obtained by removing the hairs with forceps. The hairs were mounted on microscope slides and analyzed on a standard dissecting scope.

In the experiments testing for the effect of the gene cream on dilute, the dilute by dilute produced a significant chi-square against a 4:3:2:1 ratio of dilute:wild type:cream:dilute cream. The reciprocal dilute by wild type crosses were tested for a 2:1 ratio of wild type:dilute. The dilute male data were not significant; the dilute female data were significant. The data for onset of reproduction of dilute females and wild types showed the female dilutes enter reproduction earlier than wild types. Pigment banding patterns in dilute hairs contrast sharply to wild type hairs.

The following conclusions have been made. The cream gene is required for the expression of the dilute gene but does not insure the viability of the heterozygous dilute animals. Negation of the lethal effects of the dilute gene by the cream gene will not guarantee that data will fit expected Mendelian ratios. Dilute males are responsible for observed delays in onset of reproduction. Extreme differences can be found between dilute and wild type hair banding patterns.

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